UNLOCKING DMF FUNDS TO ENABLE CLEAN ENERGY FOR SOCIAL INFRASTRUCTURE AND LIVELIHOOD IN RURAL JHARKHAND

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September 2022

Citation: Mandvi Singh, Ritwik Ray Chaudhuri and Arpo Mukherjee. (2022). *Unlocking DMF funds to enable Clean Energy for Social Infrastructure and Livelihood in Rural Jharkhand*, Sustainability Innovations and Advisories Private Limited (SIA), New Delhi, India.

Published by:
Sustainability Innovation and Advisories Private Limited (SIA).
I - 89, 8th Floor, Himalaya House, 23 K G Marg, New Delhi 110 001

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LIST OF ABBREVIATIONS

Ah	Ampere hour
AHC	Additional health centre
AMC	Annual maintenance contract
ANM	Auxiliary Nursing Midwifery
CAPEX	Capital expenditure
CESIL	Clean Energy for Social Infrastructure and Livelihood
CHC	Community health centre
CSR	Corporate social responsibility
CSTEP	Centre for Study of Science, Technology and Policy
DC	Direct current
Discom	Distribution company
DLHS	District Level Household Survey
DMF	District Mineral Foundation
DRE	Distributed renewable energy
EPC	Equipment, procurement and construction
GSVA	State's gross value added
ISEP	Initiative for Sustainable Energy Policy
JAREDA	Jharkhand Renewable Energy Development Agency
JBVNL	Jharkhand Bijli Vitaran Nigam Limited
JOHAR	Jharkhand Opportunities for Harnessing Rural Growth
Kg	Kilogram
kW	Kilowatt
MoU	Memorandum of Understanding
MNRE	Ministry of New and Renewable Energy
MSME	Micro, Small & Medium Enterprise
MW	Megawatt
NFHS	National Family Health Survey
O&M	Operations and management
OPEX	Operational expenditure
PDMU	Project Design and Monitoring Unit
PHC	Primary health centre
PHED	Public Health Engineering Department
PMKKKY	Pradha Mantri Khanij Kshetra Kalyan Yojana
PM KUSUM	Pradhan Mantri Kisan Urja Suraksha evam Utthaan Mahabhiyan Yojana
PPA	Power purchase agreement
QCBS	Quality cum cost-based selection
RESCO	Renewable Energy Service Company
Saubhagya	Pradhan Mantri Sahaj Bijli Har Ghar Yojana
SERE	Solar energy repair entrepreneur
SESE	Solar energy service entrepreneur
UDAY	Ujwal Discom Assurance Yojana
UDISE+	Unified District Information on School Education Plus
USPC	Universal solar pump controller
V	Volt
W	Watt

SUMMARY FOR STAKEHOLDERS

Background and study objective

Continued gaps in functional electrification and reliable power supply in rural Jharkhand are incapacitating the state's social infrastructure from delivering quality services and limiting livelihood avenues for a vast majority of the population. Distributed solar solutions are being deployed through government and private support to provide an immediate and effective solution for bridging the energy gap in crucial segments like health, drinking water supply, irrigation, etc. However, the scale of installations falls short against the massive requirements. Scale-up of distributed renewable energy (DRE) investments have been conditioned by limited access to finance as well as limited institutional capacity for large scale implementation. Further, optimisation of these investments has also been hindered by limited understanding of demand and lack of asset sustainability due to gaps in deployment modes and implementation models.

The mining districts of Jharkhand are uniquely placed to integrate DRE into the existing social infrastructure as well as farm and non-farm sectors, with the objective of enhancing the quality of services and productivity, by tapping into the District Mineral Foundation (DMF) funds. These funds have been created through mandatory royalty contributions by locally operating mining companies and are mandated to be spent for the socio-economic upliftment of mining-affected areas and communities. Integrating energy in the district's socio-economic infrastructure can be prioritised under DMF as power is a fundamental resource for development and growth. DMF, being a locally-grounded body, can help create an effective ecosystem that ensures the sustainability of DRE investments in the remotest of locations.

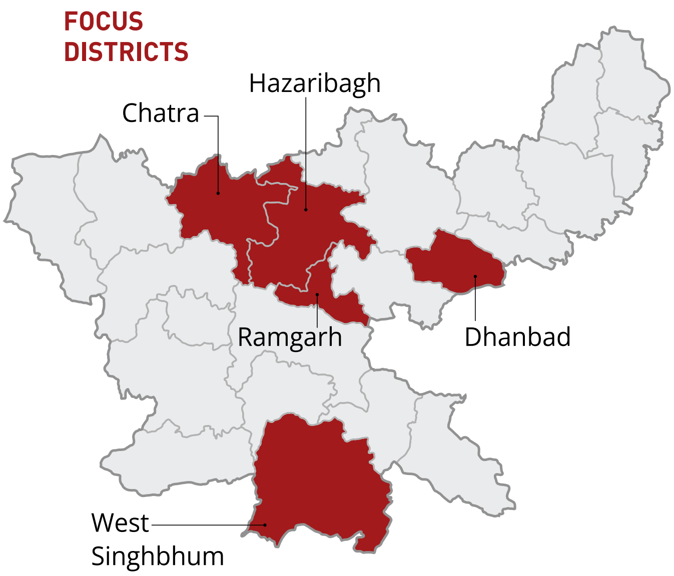
With this background, SIA designed a study to support DMFs in Jharkhand in planning DRE investments that address the most crucial needs of the rural population and ensure sustainability of investments.

Research methodology

To identify specific areas of intervention for DRE through DMF, and to demonstrate the benefit and scope of solarisation, the study included an indicative energy needs assessment survey targeted at specific socio-economic segments of Anganwadi centres, health centres, schools, farming and agri-based micro enterprises, community lighting and piped water supply. Most of these are included under priority spending areas under DMF rules, and DRE-based electrification can play a pivotal role in improving services and outcomes. The study specifically focused on five mining districts of Jharkhand – Chatra, Dhanbad, Hazaribagh, Ramgarh and West Singhbhum. These five districts have a high investment capability as they collectively account for nearly three-fourths of the total DMF accruals in Jharkhand. Besides, due to widespread multidimensional poverty among the rural populations, there is also a high requirement for investments that improve socio-economic conditions.

Further, to propose effective solar solutions and implementation frameworks for the identified socio-economic segments, the study undertakes extensive secondary research of reports, policies, rules, etc. pertaining to DRE deployment and DMF spending. The study also engages in extensive stakeholder consulations, including with a number of beneficiaries of existing solar deployment to understand experiences and identify learnings.

Figure 1: Summary of indicative survey design



FOCUS SECTORS
- Anganwadi centres
- Health sub-centres
- Primary health centres
- Schools
- Farming sector
- Agri-based micro-enterprises
- Community lighting and water supply

INQUIRY PARAMETERS
- Current energy-supply situation
- Electricity-dependent requirements and priorities
- Existing experience with RE-based applications

NUMBER OF INTERVIEWS

200 interviews to assess energy access situation at focus sectors

58 interviews with beneficiaries of solar installations

Source: SIA Assessment

Key findings and solutions

A. Access to energy remains low in rural Jharkhand due to persistent gaps in functional electrification, lack of adequate and reliable power supply, and low dependence on electrical equipment. This is critically affecting the quality of services being delivered by health, nutrition, and education centres, as well as limiting the productivity and scalability of farming and non-farming activities.

- Anganwadi centres in rural Jharkhand are facing the biggest electrification gap. As per the indicative study, 36 per cent of the surveyed centres were lacking grid-connection or a functional connection at the time of visit. This gap was highest in Chatra, with over 80 per cent of the centres lacking electrification, followed by Dhanbad and West Singhbhum at 50 per cent and 38 per cent, respectively. The three districts also reported the lowest mean duration of power supply of one to two hours during Anganwadi centre operating hours (typically from 8 AM to 1 PM), while the mean supply hours were slightly higher in Ramgarh and Hazaribagh at three to four hours.
- Health centres also report high electrification gaps, with 23 per cent of the surveyed health centres lacking grid connection or functional electrification. The gap was highest for West Singhbhum at 50 per cent and Dhanbad at 40 per cent. In these two districts, the reported power supply hours across the surveyed centres were lowest at 8-10 hours daily, while they were slighting higher at 6-12 hours for Chatra, and 6-16 hours for Ramgarh and Hazaribagh.
- Education centres are also lacking universal electrification, with the indicative survey revealing 20 per cent of the surveyed schools to be lacking grid-connection or functional electrification. The highest electrification gap was in Chatra at 33 per cent. Power supply at the electrified schools was lacking across districts in line with the overall scenario, with schools in Chatra, Dhanbad and West Singhum reporting two to three hours of mean power supply during operating hours (typically 8 AM to 2 PM), while it was reported to be three to four hours in Ramgarh and Hazaribagh.
- Agriculture electrification in Jharkhand is yet to be prioritised, and nearly 80 per cent of agriculture land remains rainfed. The reach of agriculture feeders remains weak. Nearly 60 per cent of the surveyed farmers who use electric pumps reported to be dependent on a single-phase village feeder line, which suffers from major supply irregularities and voltage issues. More than half the surveyed farmers were dependent on diesel and were majorly concerned about the rising fuel costs.

- In line with the state's expanding household electrification, majority of the agri-based micro enterprises have received grid connections, however, the dependence on diesel remains high. As per the indicative survey, 91 per cent of the surveyed businesses had grid connection, while only 40 per cent were dependent on grid supply for operations. These were largely micro-scale poultry and dairy units with minimal power dependence. However, nearly all grinding, hulling, processing, and fishery-related businesses were using diesel-run motors and were concerned about the rising fuel costs.
- Due to sustained government efforts, the reach of community lighting has increased in recent times, with 80 per cent of the surveyed panchayat representatives reporting partial availability of streetlights, and 10 per cent reporting complete availability. However, the gaps in service quality remain due to the high frequency of power cuts. Panchayats in Chatra, Dhanbad and West Singhbhum reported low levels of satisfaction.
- Drinking water supply services are being expanded in rural Jharkhand through the solar-powered *Jal Minars* (water towers) and centralised water pumping stations, however, wells and handpumps continue to be the dominant source of water supply. The survey of panchayats revealed that the daily duration of water supply through pipelines ranged from half an hour to three hours. As per the survey of beneficiaries of 32 *Jal Minars*, the technology was effective in ensuring six to eight hours for dependent households, however, 40 per cent of them reported to be facing occasional to regular breakdowns.

Power supply gaps are directly affecting outcomes: Sub-optimal electrification and deficit power supply are leading to basic challenges of lighting, cooling and water availability at health, education, and nutrition centres, rendering operations difficult and, at times, unviable. In addition, delivery of specialised services such as vaccination, maternity and neo-natal care, and emergency care at health centres, and computer education/smart classes at schools, which are highly dependent on stable power supply, are not taking off. Similarly, the productivity and scalability in primary sector is suffering due to the low level of mechanisation and the high dependence on costly and expensive diesel.

Addressing energy requirements of social infrastructure and livelihood segments is crucial for the reduction of multi-dimensional poverty in rural Jharkhand. It is particularly important to address the energy issue, as large sums of money are already being spent on building community infrastructure. The lack of reliable power supply could only lead to sub-optimal outcomes.

In the indicative survey, majority of the representatives of health centres, Anganwadis and schools flagged a number of fundamental operational challenges being created due to the lack of power supply. For instance, in case of health centres, issues pertain to vaccine and medicines getting ruined, unavailability of doctors on campus, and absence of lifesaving services etc. In schools and Anganwadi centres, lack of quality power makes classes too hot in summer and too dark in rainy season, while the education quality suffers due to lack of computer education and smart classes. There is a clear unanimity on the potential of improved electricity supply in improving the quality of services being delivered. In fact, surveyed representatives rate improved electricity scenario among the top priorities to improve the quality of social infrastructure in the state. There is also a strong demand for a complete solution, rather than partially addressing the requirements.

Similarly, in the case of major rural livelihood segments of agriculture and microenterprises, improving access to irrigation and reducing the dependence on diesel is viewed to be crucially important for improving the profitability and scalability of operations.

B. Solarisation provides a technically and financially effective solution for addressing the immediate energy requirements of social infrastructure and livelihood segments in rural Jharkhand.

In the absence of effective and comprehensive power distribution reforms that can diametrically change the power supply scenario in the state, DRE solutions are ideally placed to address the power requirements of rural Jharkhand. This is because of the modular nature of the technology that can be designed to address the specific requirements of the end user. Over the years, the solar technology has matured, and the costs have become affordable.

DRE solutions in the form of rooftop installations, standalone applications and mini grids have been widely deployed across the state to bridge the energy access gap through government subsidies and philanthropic efforts. However, these deployments have not managed the desired and required scale due to the limited institutional capacity of the Jharkhand Renewable Energy Development Agency (JREDA), financing constraints, and sustainability-related concerns.

Meanwhile, prioritising widespread and sustainable DRE deployments in the social infrastructure and livelihoods sectors is important, to bring about transformative changes in the welfare and prosperity levels of the rural population in Jharkhand, while also contributing to the greening of the grid.

The current requirements of the focus segments can be addressed through small-to-medium scale DRE interventions. For instance, the existing requirements of Anganwadi centres, health sub-centres, PHCs and schools within the district is 2 kilowatt (kW) to 5 kW systems having 2-12 hours of power back-up. The costs of these solutions vary depending on the required panel and the capacity of backup batteries.

Table 1: Solar specification and costs for social infrastructure and livelihood segments

Category	Specifications	Costs
Anganwadi centres	2 kW solar grid-connected system with 2 kW hybrid inverter; and 75 Ah (12 V) battery for two hours of backup	1,16,500
	1 HP DC solar water pump with USPC to support light and fan load; and 75 Ah (12 V) battery for two hours of backup	1,26,500
	For an Anganwadi with existing solar Jal Minar, a USPC installation for supporting lights and bulbs; and 200 Ah (12 V) battery capacity for two hours of backup	30,000
Health sub-centres	2 kW solar grid-connected system with 2 kW (24 V) hybrid inverter; and 600 Ah (12 V) battery for 12 hours of backup	1,44,000
	2 kW solar grid-connected system with 2 kW (24 V) hybrid inverter; and 300 Ah (12 V) battery for 6 hours of backup	1,27,000
	1 HP DC solar water pump with USPC to support light and fan load; and a solar freezer	1,40,000
Primary health centres	5 kW solar grid-connected system with 5 kW (24 V) hybrid inverter; and 2,000 Ah (12 V) battery for 12 hours of backup	4,30,000
	5 kW solar grid-connected system with 5 kW (24 V) hybrid inverter; and 1,000 Ah (12 V) battery for six hours of back up	3,55,000
Small schools	2 kW of solar capacity with 2 kW hybrid inverter; and 400 Ah (12 V) battery for two hours of backup	1,45,000
Large schools	5 kW of solar capacity with 2 kW hybrid inverter; and 800 Ah (12 V) battery for two hours of backup	3,25,000

Source: SIA Assessment

Meanwhile, irrigation access can be expanded through the deployment of small to medium capacity solar water pumps. The excess power generated by these solar pumps (during non-pumping hours and days) can further be harnessed through a universal solar pump controller (USPC) to support further mechanisation of farm activities. With constant decline in solar pump costs in the recent years, the per HP cost of a 1 HP pump has declined to ₹96,877, while that of a 10 HP pump has declined to ₹40,790. Adding a USPC to the system increases the costs by about ₹35,000 to ₹60,000.

The requirement of agri-based micro enterprises can be addressed through solutions varying from 2 kW to 10 kW depending on the scale of operations and costing anywhere between ₹2,00,000 and ₹9,00,000.

Solar-based centralised electrification solutions can also be explored for villages, with a large number of load centres requiring solar intervention. A mini-grid based, village electrification solution of 20 kW could meet the requirements of 5-10 load centres and can be built at an investment of ₹20 lakh to ₹25 lakh.

C. DMF funds can be harnessed for solarisation of social infrastructure and livelihood sectors to improve the quality of life of a vast number of mining affected individuals

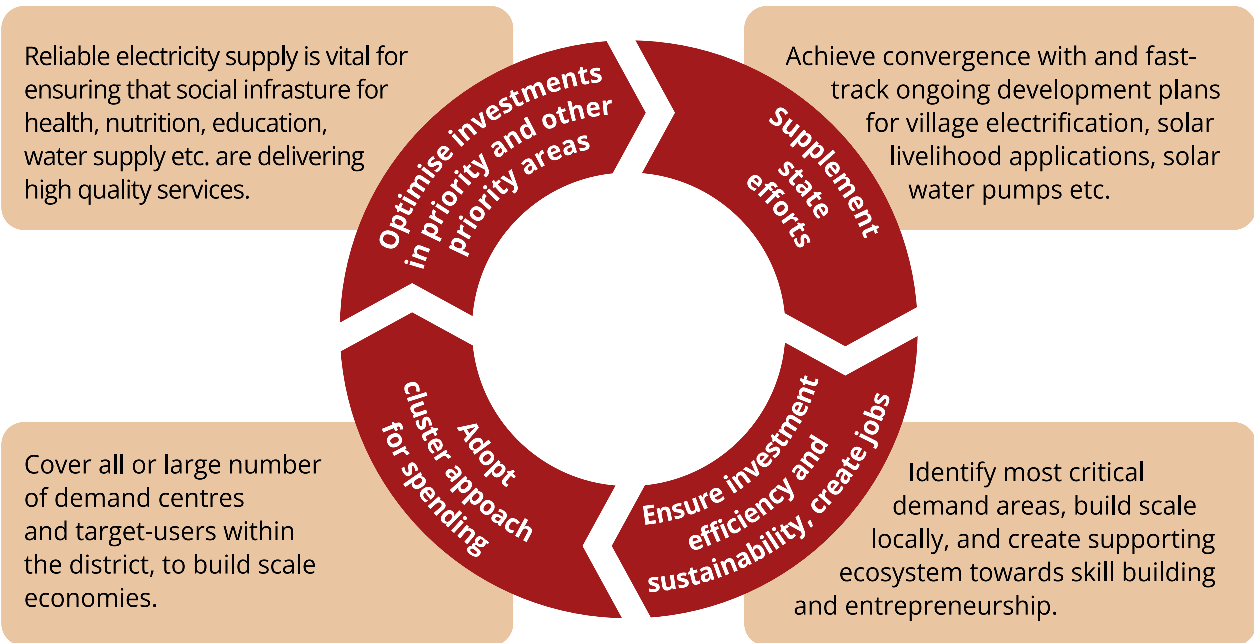
DMFs, as non-profit trusts dedicated towards socio-economic upliftment of the mining-affected communities, are ideally placed to mobilise investments towards solarisation of critical social infrastructure and livelihood segments.

Under the DMF rules 2016, there are eight high-priority areas and four other priority areas identified for investments. The high priority areas include social infrastructure development for improving drinking water, health, education, and sanitation, social welfare, livelihood, and skill development, as well as pollution control; while the other priority areas include physical infrastructure, energy, and irrigation development etc. So far, Jharkhand has accumulated ₹8,301 crore in DMF funds, of which ₹5,704 crore has been sanctioned on projects. Eighty-five per cent of the spending has so far been on drinking water supply projects, 11 per cent on sanitation, two per cent on health and one per cent on education.

While energy is listed as an 'other priority area' for DMF spending, mining-affected districts need to prioritise focused investments towards DRE deployment. This is due to the massive existing gap in grid-based energy supply in these districts, and the vital role of electricity in ensuring the delivery of basic as well as high-value services in social infrastructure and livelihood segments (as revealed by the indicative needs assessment study). This would help optimise investments in several priority and other priority areas of DMF. These spendings would also supplement the ongoing investments of central and state schemes on building energy access.

The DMFs can adopt a cluster approach to spending wherein all or majority of the demand centres can be covered at one go. Such investments can help mobilise enough scale locally to ensure efficiency and sustainability of investments. The economies of scale can not only support reduction in the costs but also help build an ecosystem for solar investments through adequate skill building and entrepreneurship support.

Figure 2: Mobilising DRE investments through DMF funds



Source: SIA Analysis

From the competing requirement areas, the priority for DRE investments can be determined based on objective assessment criteria of current need, convergence with existing schemes, DMF priority areas, and societal benefits. Under this, health centres, Anganwadi centres, schools, irrigation and micro enterprises emerge as clear priority areas for solarisation through DMF.

Table 2: Prioritisation matrix for DRE investments through DMF

	Current need	DMF priority area	Convergence with existing expenses	Convergence with existing solarisation priorities	Societal benefits
Anganwadi centres	High	High	High	Low *(No dedicated subsidy programme)*	High
Health centres	High	High	High	High	High
Schools	High	High	High	Low *(No dedicated subsidy programme)*	High
Irrigation	High	Low *(Other priority spending area)*	High	High	High
Micro-enterprises	High	High	Low *(As per existing spending)*	High	High
Community lighting	Low *(As assessed by indicative survey)*	Low *(Not in any spending category)*	Low *(As per existing spending)*	Low *(No dedicated subsidy programme)*	High
Piped water supply	Low *(Served by dedicated feeder line)*	High	High	Low *(No dedicated subsidy programme)*	Low *(Immediate financial benefits for PHED)*

Source: SIA Assessment

D. Mining districts can design and implement a "Clean Energy for Social Infrastructure and Livelihood" programme to prioritise socio-economic development of rural population.

DMFs can design and undertake a comprehensive Clean Energy for Social Infrastructure and Livelihood (CESIL) programme dedicated to enhancing the quality of services being delivered under a number of priority and other priority areas of DMF spending.

D.1 Programmatic features: The programme can be designed with the following features to ensure effectiveness and sustainability of investments:

- Focus on the most critical areas of intervention in the DMF priority segments of health, nutrition, education, and livelihood, as well as in the other priority segment of irrigation.
- Strong planning/pre-tending stage which includes memorandums of understanding (MoUs) with relevant departments, engagement of a Solar Project Design and Monitoring Unit (PDMU),and undertaking detailed needs assessment study.
- Adopt 'bundling approach' that builds scale economies and helps create a local ecosystem for solar energy technology.
- Adopt and implement robust operations and maintenance (O&M) measures including online monitoring platforms, clear provision for maintenance cost and battery replacement costs, clear identification of ownership and responsibility, and building local ecosystem for repair services.
- Development of local solar ecosystems through dedicated skill building programme, that also provides seed money for initial investments.

D.2 Implementation models: CESIL programme can look to address the requirements of energy access in critical socio-economic sectors through adoption of all or any of the following four interventions:

I. Setting up 100 solar villages through 100 per cent CAPEX investments, backed by robust O&M measures

Under this programme component, DMFs can deploy solar-backed mini-grid infrastructure in 100 villages in their respective district for powering the priority areas of health, nutrition, and education, as well as other community and commercial loads. The targeted villages should either have no power supply or have a very poor quality of power supply; as well as have a compact location of demand centres, and availability of adequate community land for setting up the infrastructure. A combined tender can be launched for setting up 20 kW mini-grid systems in the 100 identified villages.

The selected vendors should be assigned full responsibility for operating and maintaining the systems for the initial five years of the project duration. Post that, annual maintenance contracts should be awarded to solar maintenance and repair service providers. To ensure the sustainability and effectiveness of the mechanisms, the following measures should be undertaken:

- Ownership of the mini-grid should be transferred to the gram panchayat, with the village energy council set up with the overall responsibility of oversight.
- An online platform should be set up for remote performance monitoring of solar villages.
- The vendor should engage a salaried trained mini-grid operator for day-to-day operations for the first five years and set up a district-level service centre with at least two skilled technicians.
- An annual maintenance contract (AMC) should be awarded to vendors for O&M of projects after the initial five years of project operations.
- O&M fund should be established to cover the AMC contract cost through upfront contributions from DMF (5 per cent of capex) and user fees payment made by beneficiary departments/individuals aligned to their connected load.

Scale of intervention: The 100 solar village initiative would lead to the setting up of 2,000 kW of solar generation capacity in each district at an investment cost of about ₹23 crore.

II. Solarisation programmes focused on health, nutrition and/or educations sectors through 100 per cent CAPEX investments, backed by robust O&M measures

DMFs can undertake dedicated programmes to solarise the priority areas of health, nutrition, and education by blanket-covering all government-owned health centres, Anganwadi centres and schools. DMFs can choose to take up all or any one of these depending on the findings of detailed needs assessment study. A programmatic tender for the entire district can be launched to provide solar solutions ranging from 2 kW to 5 kW, with two to six hours of power back-up.

In this model as well, the selected vendors should be assigned full responsibility for operating and maintaining the systems for the initial five years of the installations. Post that, AMCs should be awarded to solar maintenance and repair service providers. To ensure the sustainability and effectiveness of the mechanisms, the following measures should be undertaken:

- Ownership of the installed assets should be handed over to beneficiary departments and one of the local representatives should be made responsible for oversight.
- An online platform should be set up for remote performance monitoring of solar assets.
- The vendor should provide O&M services for the first five years, ensured through performance monitoring and staggered payments. The vendor should establish a district-level service centre with at least two skilled technicians.
- AMC should be awarded to vendors for O&M of projects after initial five years of project operations.
- An O&M fund should be established through contributions from DMF and beneficiary departments in a 40-60 ratio during the first five years of operation.

Scale of intervention: The installed capacities and the investment requirements under this component of the programme would vary depending on the district scenario, leading to 5 megawatt (MW) to 10 MW of solar capacity addition at investments ranging from ₹35 crore to ₹75 crore.

Table 3: District-wise scope of investments under solarisation of social infrastructure

District	Segment	Potential capacity installed (kW)	Potential investment requirement (₹ crore)
Chatra	Anganwadi Centres	2,248	14.05
	Health sub-centres	186	1.30
	PHCs	45	0.39
	Schools	4,464	34.97
Dhanbad	Anganwadi Centres	3,822	23.89
	Health sub-centres	280	1.96
	PHCs	165	1.42
	Schools	5,913	46.32
Hazaribagh	Anganwadi Centres	3,540	22.13
	Health sub-centres	258	1.81
	PHCs	65	0.56
	Schools	5,427	42.51
Ramgarh	Anganwadi Centres	2,084	13.03
	Health sub-centres	486	3.40
	PHCs	125	1.08
	Schools	2,244	17.58
West Singhbhum	Anganwadi Centres	4,660	29.13
	Health sub-centres	310	2.17
	PHCs	35	0.30
	Schools	5,352	41.92

Source: SIA Estimates

III. Deployment of 1,000 off-grid solar water pumps through 90 per cent capital subsidy

DMFs can undertake a dedicated irrigation expansion programme through solar water pumps. In the first phase, the programme can target the deployment of 1,000 solar water pumps, focusing particularly on marginal, small, and medium farmers. The programme can match the subsidy being provided under the Pradhan Mantri Kisan Urja Suraksha evam Utthaan Mahabhiyan (PM KUSUM), the ongoing solar pump scheme of the government, which provides 90 per cent subsidy to beneficiary farmers in Jharkhand.

A comprehensive tender for 1,000 pumps can be launched for solar water pumps with USPC of varying capacities – micro pumps to up to 7.5 HP pumps – depending on agricultural land ownership. The selected vendors should be assigned full responsibility for providing maintenance and repair services for the initial five years of the installations. After five years, AMCs should be awarded to solar maintenance and repair service providers. To ensure the sustainability and effectiveness of the mechanism, the following measures should be undertaken:

- Ownership of the installed pumps should be handed over to the respective farmers after adequate training is provided pertaining to operations and basic troubleshooting.
- An online platform should be set up for remote performance monitoring of solar pumps.
- The vendor must provide O&M services for the first five years, ensured through performance monitoring and staggered payments. The vendor should establish a district-level service centre with at least two skilled technicians, as well as commit to providing hand-holding support to the farmers for a year.

- The PDMU must facilitate farmers in accessing vendor services, ensuring efficiency of service delivery.
- Farmers must take care of maintenance and repair on their own after five years through private solar repair centres.

Scale of intervention: Covering 1,000 farmers under a solar pump deployment initiative would lead to about 3 MW of solar capacity deployment in each district at an investment cost of about ₹19 crore.

IV. Creation of 100 solar entrepreneurs for providing Renewable Energy Service Company (RESCO) services in rural Jharkhand, and 50 solar entrepreneurs for solar repair services

For building a solar ecosystem locally, DMF can launch a solar entrepreneurship programme focused on developing entrepreneurial and solar-oriented skills among the unemployed rural youths willing to create solar-based micro enterprises. The programme can target incubating 50 solar energy service entrepreneurs (SESEs) who can provide comprehensive solar installation, operation, and maintenance services in rural Jharkhand. They can be provided seed funding support to set up 50 kW of solar capacity on the RESCO model for private Micro, Small & Medium Enterprises (MSMEs), schools, hospitals, and other load centres. The funding support could be provided in equity grants through DMF, and a bank loan ratio of 60:40.

DMF can further incubate 100 solar energy repair entrepreneurs (SEREs) for delivering comprehensive after-sales services in rural Jharkhand. These entrepreneurs are capacitated with technical training as well as seed funding support for setting up the business.

This initiative should focus on three key components:

- Entrepreneurship training in traditional and emerging skills of business incorporation, management, expansion, and sustenance.
- Technical training, which includes understanding the basic principles of DRE technologies and applications, as well as solar assembling, installation, and maintenance.
- Seed funding as a mix of equity grant and loan for SESEs, and 100 per cent equity grant for SEREs.

Scale of intervention: Covering 50 SESEs linked to a RESCO development programme of 50 kW each would lead to 2.5 MW of capacity in each district. This could cost ₹15.3 crore, including the cost of skill building and capital support for RESCO installations.

While supporting the development of 100 SEREs would not directly lead to solar capacity addition, it would play a crucial role in ensuring the sustainability of investments being made under all solarisation efforts in the district by ensuring local availability of repair services. This would require an investment budget of about ₹1.5 crore including skill building and seed funding support for business initiation.

D.3 District-wise scale of intervention

CESIL programme in its entirety would lead to substantial solar capacity addition in each district, ranging from 12 MW to 18 MW of solar capacity. The investment requirements range from ₹94 crore to ₹132 crore, which is only a small proportion of the DMF accruals in each of the districts.

Table 4: Scope of intervention under SIA's proposed CESIL programme

	Potential capacity installed (MW)	Total funding requirement (₹ crore)
Chatra	14.44	109.32
Dhanbad	17.68	132.20
Hazaribagh	16.79	125.61
Ramgarh	12.44	93.69
West Singhbhum	17.86	132.13

Source: SIA Estimates


Arpo Mukherjee, SIA

1. INTRODUCTION

Reliable electricity supply continues to elude rural Jharkhand, despite the roll-out of mega government schemes for grid expansion and multiple private/philanthropic initiatives for expanding the presence of distributed renewable energy (DRE). Households face daily power cuts lasting several hours, while a part of the critical social infrastructure still awaits grid connection. This gap in electricity access has become a fundamental roadblock in Jharkhand's socio-economic development and requires the highest policy consideration.

Improving the quality of grid-based supply, at this point, entails a humongous, multi-year effort to achieve transformative institutional and infrastructural changes in the state's power distribution sector. It is thus widely accepted that DRE-based solutions are most optimally placed to provide high-quality, clean electricity in rural Jharkhand for improving the quality of life. Government and private efforts in the past decade have already successfully demonstrated the effectiveness of DRE, and built confidence among the masses. The challenge now is that of scaling-up the DRE presence, ensuring its sustainability, and using these solutions as tools for change.

In the mining-affected districts of Jharkhand, District Mineral Foundation (DMF) with its mandate to 'work for the interest and benefit of persons, and areas affected by mining-related operations' provides a fitting source of funding to support DRE scale-up to upgrade the quality of services being delivered by health, education or other social infrastructure, as well as build livelihood generation capabilities for the local population.

This report explores the potential of DMF to support DRE deployments for social infrastructure and livelihood generation. It is based on an indicative ground-level survey in five mining-affected districts of Jharkhand and assesses the energy needs and requirements of rural communities. It proposes DRE solutions and implementation frameworks supported by the DMF funds. The core objective is to support DMFs in enhancing investments in clean energy to improve the quality of services being delivered by the exiting social infrastructure and enhance livelihood potential.

1.1 ENERGY ACCESS IN JHARKHAND

Jharkhand achieved the milestone of universal household electrification through the efforts put under the national government's Pradhan Mantri Sahaj Bijli Har Ghar Yojana (Saubhagya). Officially now all the 'willing' households in rural and urban Jharkhand have been electrified. Achieving this entailed electrification of nearly 1.7 million households, which is equivalent to about a quarter of the state's total number of households, in a short period of under three years.[1]

Despite the impressive grid expansion, glaring gaps in electrification persist, both at the household-level as well as across specific livelihood clusters and infrastructure segments. This is evidenced primarily by a number of ground-level reports and surveys, as official consolidated data from central and state power ministries or departments is not available.

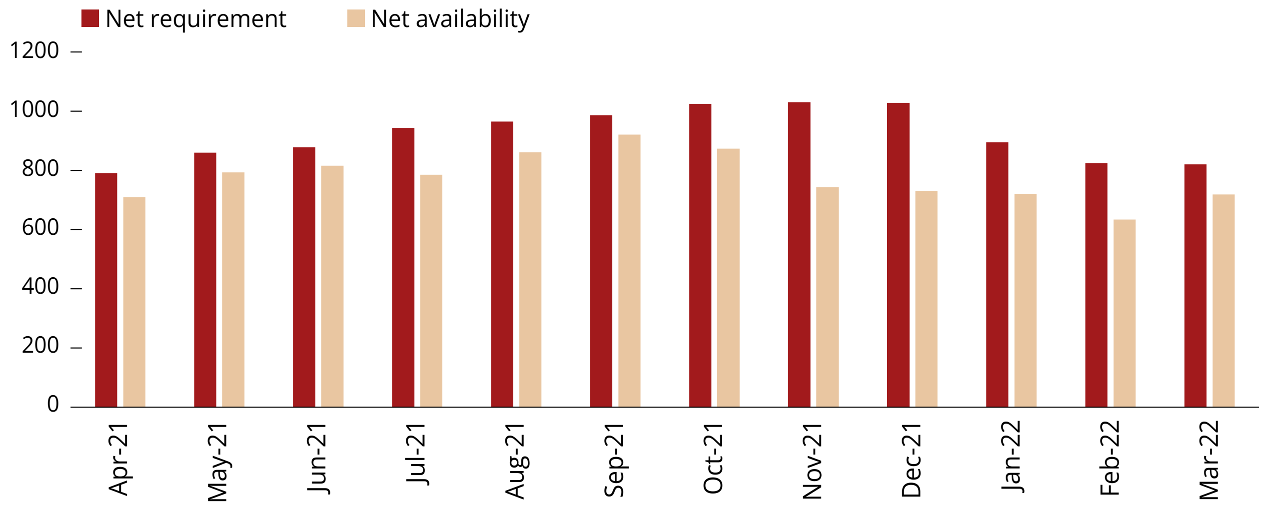
The recently-concluded National Family Health Survey-5 (NFHS-5) , which surveyed 22,863 urban and rural households in Jharkhand between January 2020 and April 2021, found 6.2 per cent of the surveyed household to be unelectrified.[2] Another survey of 1,440 rural households conducted by the Initiative for Sustainable Energy Policy (ISEP) across all 24 districts in Jharkhand between July and August 2019 had found that nearly 13 per cent of the surveyed households did not have any form of electricity access.[3] Meanwhile, an analysis of District Level Household Survey (DLHS) data from between 2008-09 and 2012-13 by the Council on Energy, Environment and Water had indicated that 35 per cent of the primary health centres (PHCs) did not have electricity connection.[4] The 2020-21 report by the Unified District Information on School Education Plus (UDISE+) found that out of the 45,319 schools in the state, 2,423 schools do not have electric facilities and another 3,970 schools do not have functional electric facilities.[5]

As for the power supply situation, the official data on the hours of power supply in urban and rural Jharkhand is not available.[6] However, the inadequacy is clearly reflected in deficits reported under the state's power supply position. For 2021-22, Jharkhand's energy deficit was 4.4 per cent and the peak deficit was 12.2 per cent, both being the second highest in the country.[7]

18 kWp Micro-grid in Gumla

Arpo Mukherjee, SIA

Graph 1.1: Jharkhand's net power requirement and availability



Source: Eastern Regional Power Committee

However, the officially reported deficits also do not reflect the actual situation due to suppressed demand. Power cuts and load shedding remain rampant in Jharkhand. The ISEP's 2019 survey had revealed the median rural household supply to be only 10 hours per day, and typically for over five days per month electricity remains entirely unavailable. This has severely impacted the quality of health, education and other social services delivered in the state, as well as limited the productivity and expansion of electricity use-oriented livelihood opportunities.

1.2 DRE SCENARIO IN JHARKHAND

Decentralised and off-grid solutions are optimally positioned to address the electrification gap and energy deficit in rural Jharkhand, due to their modular nature, stable technology, affordable costs, and easy installation.

The DRE applications have been deployed in Jharkhand by central and state government subsidies and roll-out schemes. The state government had initially notified a Solar Power Policy in 2015 and dedicated the Solar Rooftop Policy in 2018 to promote the installation of DRE systems in the state. The emphasis on DRE continues under the newly-released Jharkhand Solar Policy 2022, which targets deployment of 280 MW of off-grid projects and 250 MW of solar agriculture.[8] Over the years, the state government has launched a number of schemes, programmes and guidelines for the promotion of mini-grids, solar water pumps, solar PV based cold storage, solar street lights, solarisation of hospitals etc., utilising the funds provided by the Ministry of New and Renewable Energy (MNRE). A number of demonstrations and installations of the DRE technologies have also come up in the state through the efforts of independent organisations /philanthropies working with rural communities.[9] However, these public and private efforts have failed to achieve the desired scale, as the challenges of financing and sustainability of installations remain insurmountable.

As of June 2022, around 97.1 MW of renewable energy capacity has been installed in Jharkhand, including 89.8 MW of solar, 4.3 MW of bio-power and 4 MW of small hydro capacity. Of the installed solar capacity in the state, 22 per cent is ground mounted, while rooftop and distributed off-grid capacity is 39 per cent each. The off-grid capacity includes solar lights, solar pumps, mini-grids, biogas installations etc.[10]

Overall, the state holds only a marginal share in the national off-grid technology deployments and the penetration remains quite low relative to the requirement. The total off-grid installations in the state account

Privately installed solar panel at a small shop in Dhanbad Arpo Mukherjee, SIA

for only 2 per cent of the national total, and rooftop installations account for 1 per cent share. Only in case of solar lantern and village electrification, the share is higher at about 8-9 per cent. It is to be noted that the actual installments of off-grid equipment may aggregate to a little higher than the officially reported data due to incomplete tracking of installation that do not avail central or state subsidies.

Table 1.1: Status of decentralised off-grid renewable installations in Jharkhand

DRE Technology	Unit	Installations in Jharkhand	Installations in India	Share in total (%)
Biogas plants	Number	7,489	49,56,668	0.2%
Solar street lights	Number	14,344	9,34,941	1.5%
Solar home lighting system	Number	9,450	17,23,479	0.5%
Solar lantern	Number	7,90,515	84,59,119	9.3%
Power packs (off-grid)	kWp	3769	2,16,862	1.7%
Solar power packs (Comp. A)	kW	-	36,000	-
Solar pumps (Comp. B)	Number	11,387	3,49,781	3.3%
Hybrid systems	kW	-	3,292	-
Village electrification	Number	700	8,979	7.8%
Hamlet electrification	Number	-	2,329	-
Solar pumps (Comp C)	Number	-	1,026	-

Source: MNRE, as of March 2022

Overall, the DRE sector in India has been responding to the demand for adaptable, affordable, and productive end-use of energy, moving past the usual lighting solutions. In the primary sector, interventions are being observed across value chains – agriculture, horticulture, floriculture, poultry, dairy, and fisheries, etc. Similarly, in the non-farm segment, DRE is leading to substantial economic and social gains through interventions in lighting, ventilation, processing, storage etc.

Multiple examples of individual and community-based deployment models for such DRE applications have been tried in Jharkhand. The masses have increasingly become aware of the potential benefits of solar, having witnessed the DRE installations of some form in their vicinity. However, the scalability and replicability of such installations at the required pace have been lacking due to a number of reasons:

a) Limited access to finance: As the solar power sector matured in the past decade, the cost of solar-based DRE solutions decreased considerably. For instance, the cost of a 5 HP solar water pump has decreased by nearly 60 per cent, from ₹1,42,500 per HP in 2013-14 to ₹51,130 per HP in 2021-22, as per the MNRE published benchmarks.[11] With nearly negligible O&M costs, off-grid technologies typically have a payback period of five to seven years, depending on the cost of alternative fuels and the sector of deployment.

A majority of end users in rural Jharkhand, despite being adequately aware of the benefits of solar as a stable source of power, find it difficult to pay the capital costs up-front. There is also limited lending support available for such technologies from financial institutions, due to inadequate technology awareness and limited reach.

Therefore, in rural areas, subsidies have played a crucial role in bridging the finance gap. These have either been provided by central or state renewable energy ministries or agencies or through finance commission or other development support fund, or the installations have been subsidised by impact investors and corporate social responsibility (CSR) funds. Majority of these have been set up without user fee, while some community installations such as mini-grids, have sought user fees to ensure maintenance of equipment. But the limited availability of such funds and their non-local nature limits the scale of intervention and fails to ensure suitability of investments.

Cold storage system installed in Gumla Arpo Mukherjee, SIA

In many states, especially for urban consumers, Renewable energy service companies (RESCOs) have emerged to address this funding challenge wherein the end-user is not required to pay anything upfront for solar installation; consumers either collect a roof-rent for installed solar or purchase power from the RESCO at rates much lower than the grid tariff under a power purchase agreement (PPA). But the RESCO model has not taken roots in Jharkhand or rural India.

b) Institutional challenges: Comprehensive policy and institutional support catering to the specific requirements of the DRE segment have been largely missing in the state. Jharkhand Renewable Energy Development Agency (JAREDA) under the Department of Energy is responsible for promoting the use of renewable energy in the state through fiscal and financial incentives available through MNRE or under state policies. However, relative to the task at hand, given the massive energy access gap in the state, the scale of intervention of the JAREDA has been limited by its own institutional strength and capacity.[12]

This has not only created limits on new spending but also on the monitoring of installed assets, leading to the sustainability of investments becoming a key concern. Further, there are coordination-related challenges and delays as inter-department attention is required at multiple stages of planning and implementation. Overall, there are long-standing gaps in the state's administrative mechanism, which requires massive transformation reforms, that limit both the scale and the pace of DRE deployment as well as affects investment sustainability.

c) Limited understanding of demand: Decentralised solar solutions can be customised to meet the specific requirements of the end-users. Detailed needs assessment studies are, therefore, crucial for understanding the requirement (of the target village or farmers or health centres or schools) and then designing the scope of intervention. Technology providers and investors often find it difficult to identify the requirements due to the limited market information and understanding of the local markets. This often leads to the installation of supply-centric applications, which either inadequately address the user requirement or leads to under-utlisation of the DRE solution.

d) Lack of sustainability of DRE interventions: DRE installations in Jharkhand have typically involved multiple parties, with the frameworks of monitoring and the onus of maintenance not clearly established. Funding is provided by government schemes or private funds that make one-time investments; equipment is sourced and installed by a private company that often does not have a local presence, while the user is either an individual or community who does not know who to approach in case of equipment malfunction. An effective service market is missing in the state due to the unclear onus of monitoring asset performance, missing local capacity of equipment suppliers and lack of locally trained technicians. This gap affects the sustainability of installations, leading to doubts among decision-makers on the investment viability and the impact on the ground.

1.3 STUDY OBJECTIVE

The objective of this study is to support major DMFs of Jharkhand in making focused investments in clean energy in rural areas for enhancing the quality of service delivered by social infrastructure segments and livelihoods opportunities for the mining-affected communities. Conducive policy environment, institutional support, market demand, availability of finance, adequate workforce, and technology innovation play a key role in strengthening the ecosystem of the DRE sector in rural Jharkhand.[13] The present study focuses on addressing some of these fundamental challenges through the following measures:

a. Indicative needs assessment through ground-level studies: Developing a baseline understanding of the scenario is important to clearly establish the existing energy demand, energy use pattern and the feasibility of DRE deployment in the focus sector. Though the energy access gap in the state is well established, clear data on the ground-level scenario is not available. Once the most pressing needs are identified in the target sectors, a practical and effective approach for increasing energy access can be developed. To do this, indicative needs assessment studies were conducted in focus districts, using an approach aligned with the 'Framework for Promotion of DRE Livelihood Applications' published by the MNRE in February 2022. The approach provides for the assessment of demand as the first step to mapping the needs of the beneficiaries and understanding the possibilities of DRE deployment across various sectors.[14]

b. Bridging the financing and institutional support gap through DMF: Mining districts of India have access to massive amounts of DMF funds, created through mandatory contributions by the operating mining companies. DMFs have been set up as 'non-profit trusts' with a mandate to spend for the socio-economic upliftment of directly and indirectly mining-affected areas. Since power is a fundamental development need, enhancing energy access to improve socio-economic conditions can be prioritised under DMF. Further, DMF being a locally-stationed body can mobilise local authorities and grassroots organisations to create an effective ecosystem for DRE implementation that drives DRE development and ensures sustainability of investments. DMF funds, thus, hold a significant potential to support the deployment and scaling up of DRE installations in rural Jharkhand for enhancing livelihood and income opportunities, improving healthcare access, and supporting educational infrastructure improvement.

The following chapters of the report describe the methodology and results of the indicative needs assessment study, identifying key areas of potential DRE investments through DMF and the scope of solarisation. This is followed by the chapter that describes the potential of DMF for funding such investments and the possible implementation models for ensuring sustainable investments in the focus districts. The concluding chapter provides the framework for DMF-DRE investments in the mining-affected areas.

Maskur Alam, surveyor

2. ENERGY NEEDS ASSESSMENT METHODOLOGY

Ground-level assessments were undertaken in leading mining districts of Jharkhand to evaluate the existing energy access gap, use pattern and requirements in key social and economic infrastructure. This indicative assessment was done for identifying the scope of distributed renewable energy (DRE) in improving the socio-economic scenario, and the scope of supporting the investments in energy access made in rural areas through District Mineral Fund (DMF).

2.1 METHODOLOGY

Selection of focus districts: Given the study's objective, the focus is on five leading mining districts of Jharkhand with substantial DMF fund accruals. These are Chatra, Dhanbad, West Singhbhum, Ramgarh and Hazaribagh districts, that collectively account for three-fourths of the total DMF accruals in Jharkhand. Dhanbad alone accounts for a quarter of the state-level accruals, followed by West Singhbhum at 22 per cent and Ramgarh and Chatra at 11 per cent each, and Hazaribagh at 5 per cent.

Table 2.1: District-wise DMF accruals in the five focus districts (₹ Crore)

District	DMF accruals from coal/ lignite	DMF accruals from other major minerals	DMF accruals from minor minerals	Total DMF accruals	Share in state total (%)
Dhanbad	2,028	0	13	2,041	25%
West Singhbhum	0	1,752	10	1,762	22%
Ramgarh	870	0	5	875	11%
Chatra	906	0	9	915	11%
Hazaribagh	378	0	4	382	5%
Jharkhand	**5,790**	**1,887**	**422**	**8,099**	**-**

Source: Department of Industries, Mines and Geology, Jharkhand; as of January 2022.

In all the five districts, there is a large section of the population living in rural areas – 85 to 90 per cent in case of West Singhbhum, Chatra and Hazaribagh; and 40 to 50 per cent in case of Dhanbad and Ramgarh. There is widespread multi-dimensional poverty in each of these districts, especially in rural areas, as assessed by the NITI Aayog's 2021 National Multidimensional Poverty Index Baseline Report. The share of the rural population assessed to be multi-dimensionally poor – based on the parameters of health, education and standard of living – is over 60 per cent for Chatra and West Singhbhum, and about 40 per cent for the remaining three districts.

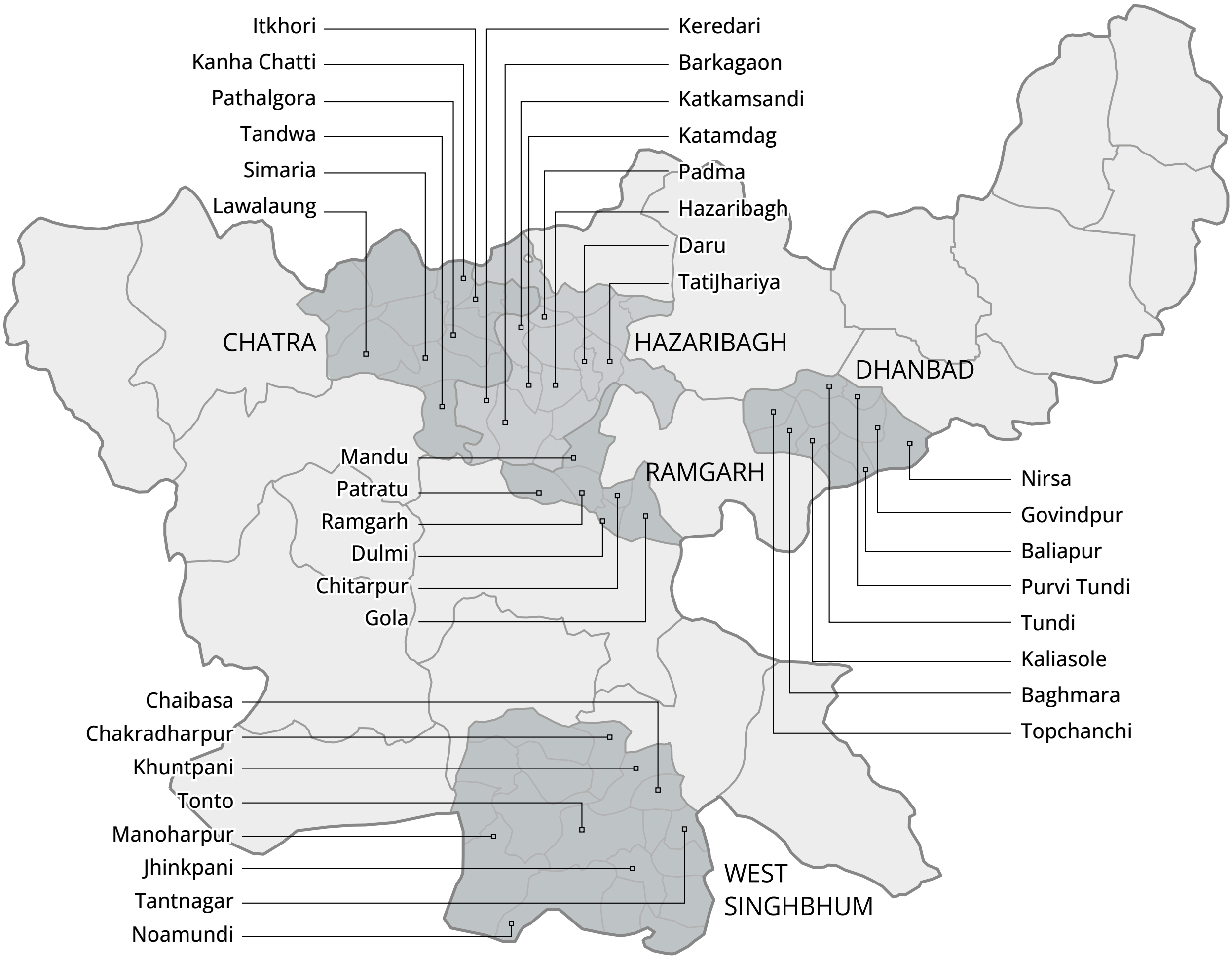
Table 2.2: Key socio-economic indicators in focus districts

Indicators	West Singhbhum	Chatra	Ramgarh	Dhanbad	Hazaribagh
Block	18	12	6	10	16
Panchayat	106	154	125	256	257
Village	1,642	1,377	351	1,333	1,324
Rural population	16,14,182	11,51,471	7,40,668	14,41,011	19,00,507
SC population share in rural	9%	34%	12%	16%	18%
ST population share in rural	50%	5%	27%	15%	8%
Share of multi-dimensionally poor population	57.6%	60.74%	29.80%	28.57%	35.75%
Share of multi-dimensionally poor rural population	64.13%	63.10%	37.12%	40.45%	39.78%

Source: Jal Jeevan Mission; NITI Aayog

Sample selection: There are 62 blocks in the five focus districts. Considering a 95 per cent confidence level and 10 per cent error margin, a representative sample of 36 blocks was selected for ground-level assessment. This included eight blocks each in Dhanbad, Hazaribagh and West Singhbhum, and six blocks each in Chatra and Ramgarh. In each sample block, one or two panchayats were randomly selected for the survey.

Figure 2.1: Blocks covered under indicative needs assessment survey



For each panchayat, a survey was designed to focus on specific segments based on the priority areas and other areas of DMF spending, where DRE-based electrification can play a significant role in improving socio-economic outcomes. These included hospitals, Anganwadi centres, schools, farming and agri-based microenterprises, community lighting and piped water supply etc.

Table 2.3: Focus sector under indicative needs assessment survey

DMF investment area	Surveyed vertical	Target respondents
Health care	Health centres	Doctor-in-charge/Officer-in-charge/ Caretaker
Education	Schools	Head Master/Principal
Women and Child Welfare and Development	Anganwadi centres	Person-in-charge/Anganwadi *Didi*
Irrigation & Agriculture	Farming sector	Farmer
Livelihoods	Agri-based microenterprises	Entrepreneurs
Community Lighting & Water	Panchayat office	Panchayat Mukhiya/Up-Mukhiya/Sewak/ General Assistant

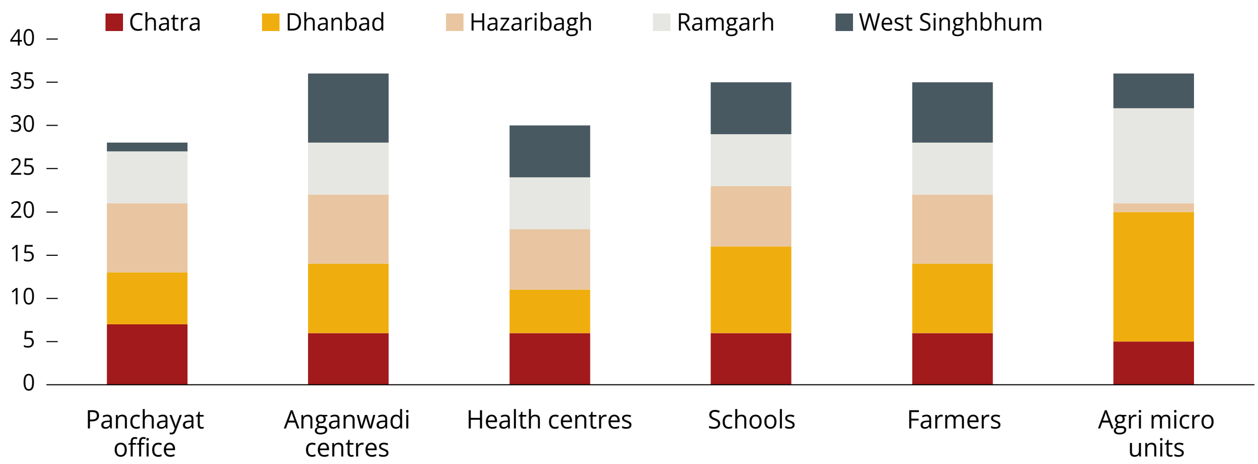
Dedicated questionnaires were designed for each of the target sectors to address the following key inquiry parameters:

a. Current energy-supply situation to establish the existing energy gap in terms of quantity and quality of power supply, and its impact
b. Electricity-dependent requirements and priorities
c. Existing experience with RE-based applications, if any

Overall, 258 responses were collected across the five districts. These included 200 interviews to assess the energy access-related requirements, including Anganwadi centres (18 per cent of the interviews), health centres (15 per cent), schools (18 per cent), farmers (18 per cent), agri-based microenterprises (18 per cent) and panchayat offices (14 per cent).

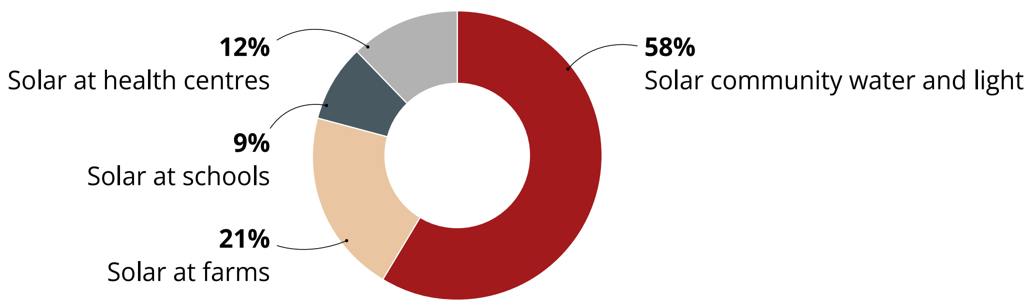
In addition, 58 end-user interviews were conducted to assess the experience with solar installations, including beneficiaries of solar drinking water and lighting units (59 per cent), solar water pumps and other equipment (12 per cent), solar at health centres (7 per cent), and solar schools (5 per cent).

Graph 2.1: Category-wise number of interviews conducted for indicative energy needs assessment



Source: SIA Survey

Graph 2.2: Category-wise solar installations surveyed



Source: SIA Survey

Arpo Mukherjee, SIA

3. ENERGY ACCESS SCENARIO ACROSS KEY SECTORS

The ground-level surveys in rural panchayats of the five focus districts reveal massive power supply gaps. The mean household power supply is reported to range from 6-18 hours, with relatively higher hours of supply reported by panchayats in Ramgarh and Hazaribagh, and lower hours reported by Chatra, West Singhbhum and Dhanbad. Universal electrification still appears to be missing in a few panchayats, with grid connection gaps reported at households, schools, hospitals etc. There is also low reliance on electrical equipment which is critically affecting the quality of services being delivered by the social infrastructure facilities, as well as impacting the productivity of economic activities in rural areas.

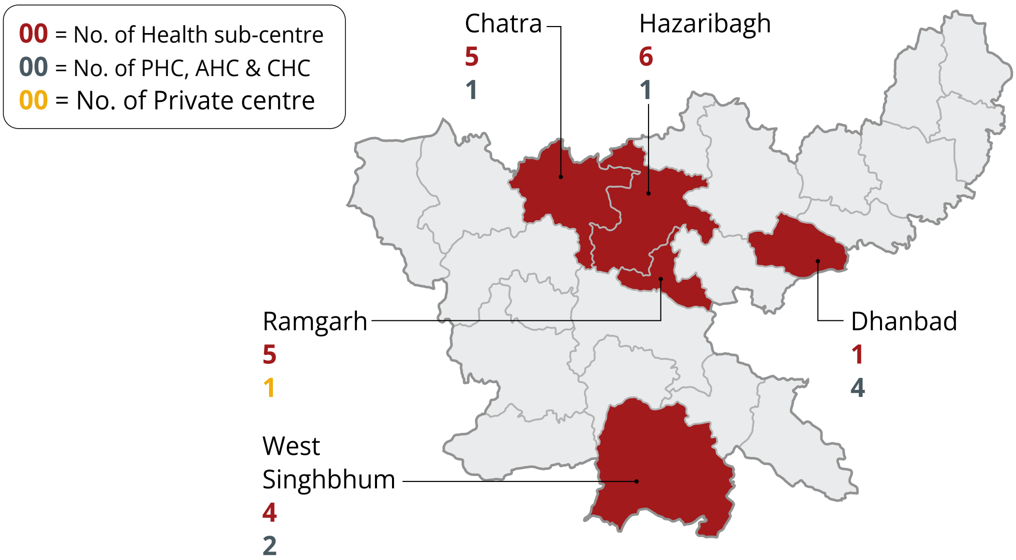
3.1 HEALTH CENTRES

Major electrification gaps seen in West Singhbhum and Dhanbad; power supply lacking across all districts leading to low dependence on electrical equipment and operational challenges

Thirty health centres were randomly surveyed across the five focus districts to assess the electricity access scenario. This included five centres in Dhanbad, six each in Chatra, Ramgarh and West Singhbhum, and seven in Hazaribagh. Of the total, 21 were health sub-centres , six were primary health centres (PHCs), and one each was additional health centre (AHC), community health centre (CHC) and a private hospital.

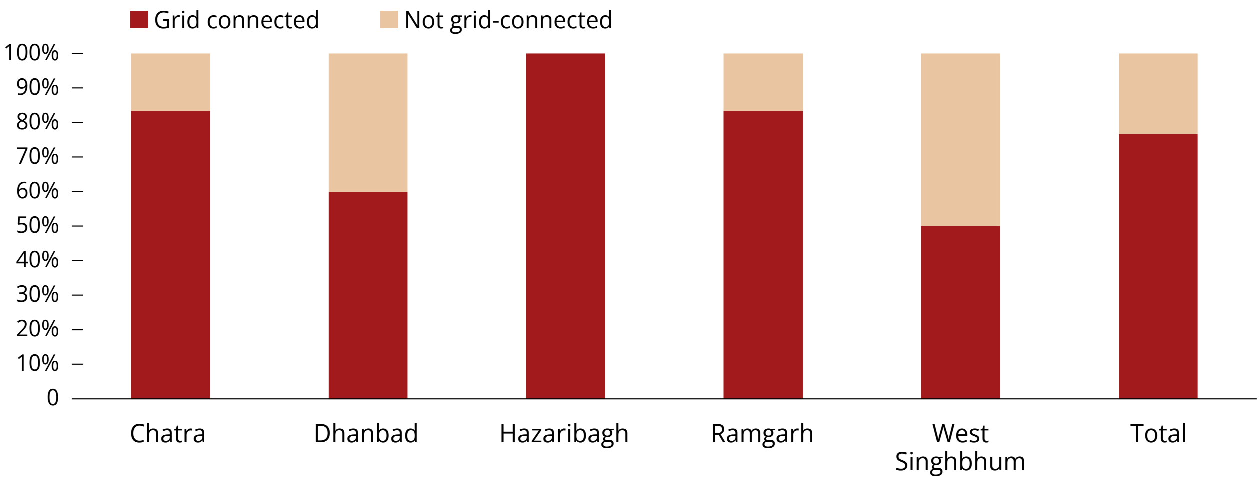
- Overall, 23 per cent of the surveyed health centres were found not to be connected with the grid, most of them being health sub-centres. These included some cases where the connection had failed due to faulty power lines and were awaiting repairs since several months (at least three months).
- The electrification gap was seen to be highest in West Singhbhum at 50 per cent , followed by 40 per cent in Dhanbad and 17 per cent each in Chatra and Ramgarh. While the electrification gap was mostly at the level of sub-centres , one PHC each was also missing active grid connection in Dhanbad and West Singhbhum. Only in Hazaribagh, all randomly selected health centres had functional grid connection.
- The reported grid power supply at health centres was lowest – at under five hours daily – in Dhanbad and West Singhbhum, while it was under 12 hours in Chatra and under 16 hours in Hazaribagh and Ramgarh. The power supply was reported to be of low voltage for nearly 25 per cent to 40 per cent of supply duration.
- Only three grid-connected hospitals, one each in Hazaribagh, Ramgarh and West Singhbhum, reported to have a diesel generator for power supply back-up. These included a private hospital, one CHC and one PHC.
- Typically, health sub-centres included one-two fans and bulbs, with only five out of the 21 having a functioning fridge to store medicines and vaccines, and six having drinking water facility. Meanwhile, PHCs were typically observed to include 10-20 fans and 10-20 bulbs. Fifty per cent of the centres had a refrigerator. A newly-developed PHC in Dhanbad had an operation theatre built and a water pump installed, both of which were non-functional at the time of the survey.
- All the surveyed representatives at the grid-connected health centres in Dhanbad, Hazaribagh and West Singhbhum and 80 per cent of the representatives in Chatra reported to be regularly facing operational challenges due to the power supply situation. Only in Ramgarh, the frequency of operational challenges was reported to be occasional to rare. Overall, inadequate supply hours were flagged as the biggest concern, followed by low voltage supply and infrequent power supply.

Figure 3.1: Details of surveyed health centres in the focus district



Source: SIA Survey

Graph 3.1: Status of grid connection at surveyed health centres in the focus districts



Source: SIA Survey

Table 3.1: Average hours of daily power supply at surveyed grid-connected health centres

District	Average daily power supply duration (hours)	Average low voltage power supply duration (hours)
Chatra	12-6	4-2
Dhanbad	10-6	4-2
Hazaribagh	16-6	5-2
Ramgarh	16-12	4-2
West Singhbhum	10-8	3-2

Source: SIA survey

Newly set up PHC in Dhanbad

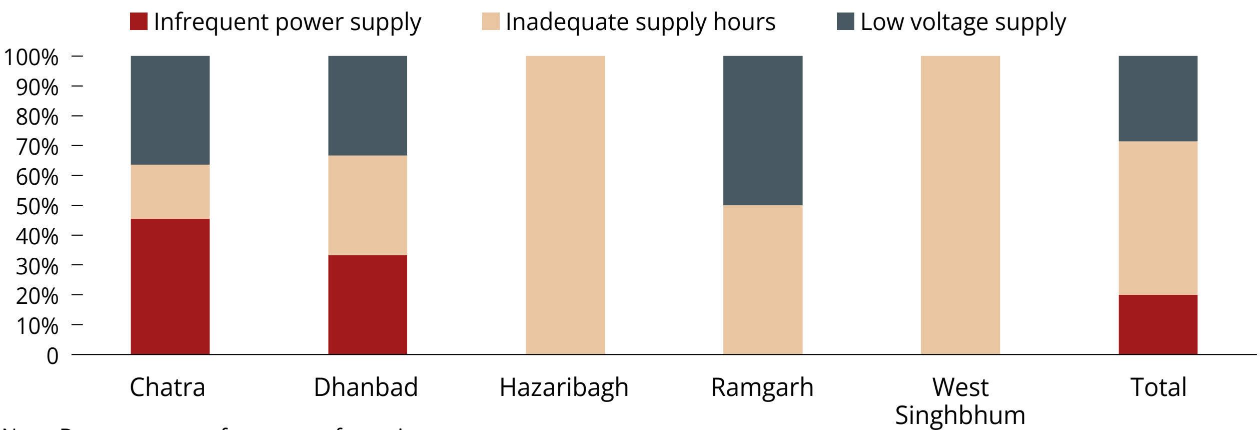
Mandvi Singh, SIA

Figure 3.2: Electrical fittings/equipment available at health centres

Health sub-centres	PHCs
Average availability of one-two fans and bulbs	Average availability of 10-20 fans and bulbs
25% of the centres had a functional fridge to store medicines and vaccines	50% of the centres had a functional fridge to store medicines and vaccines
30% of the cnetres had a functioning water pump	25% of the centres had functioning water pump

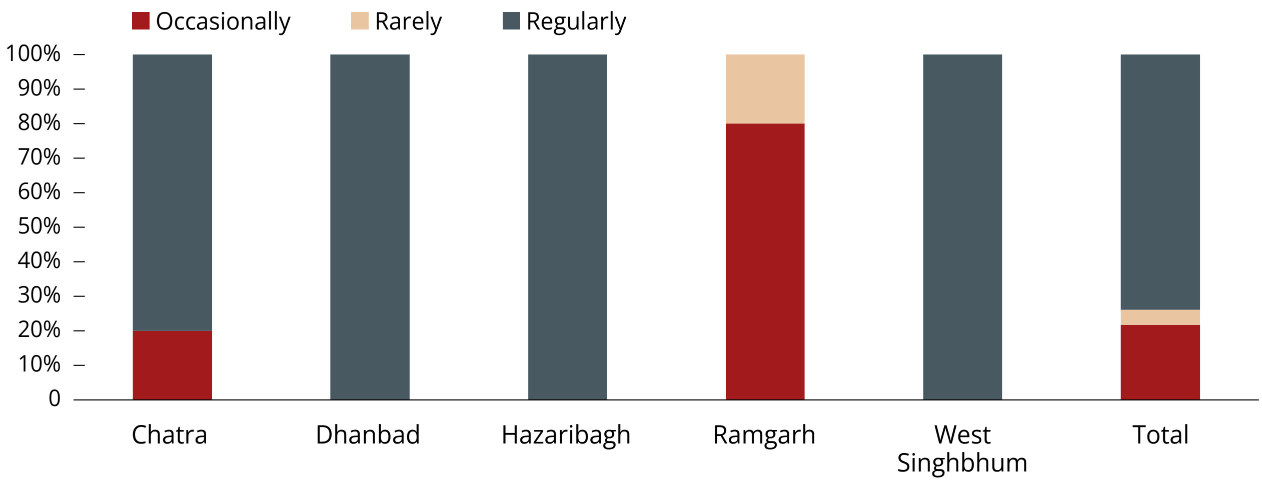
Source: SIA survey

Graph 3.2: Reported issues with grid power supply faced by surveyed grid-connected health centres



Note: Data represents frequency of mentions
Source: SIA survey

Graph 3.3: Reported frequency of issues faced by surveyed grid-connected health centres



Source: SIA survey

3.2 ANGANWADI CENTRES

Major electrification gaps seen in Dhanbad and Chatra; power supply gap highest in Dhanbad, Chatra and West Singhbhum.

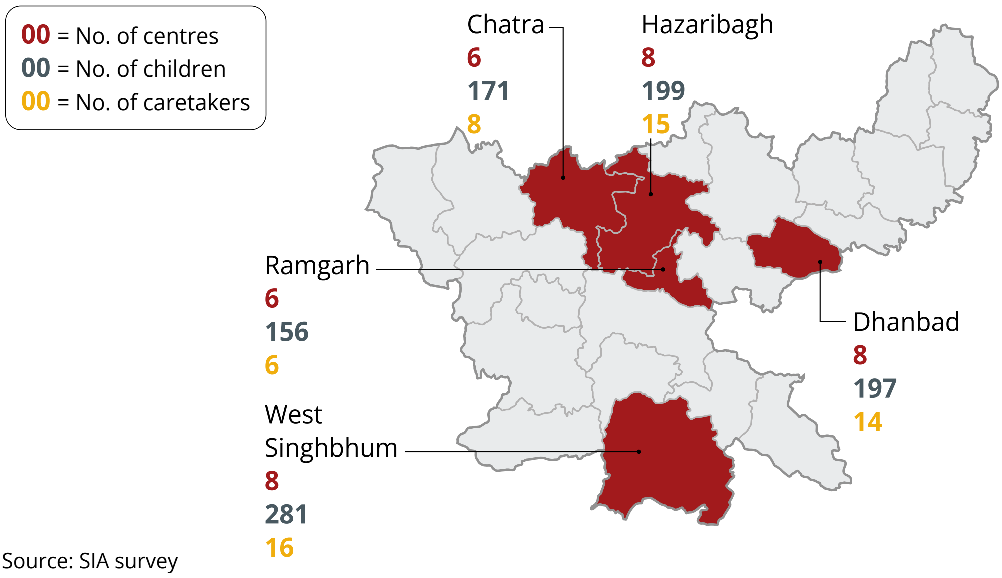
Across five focus districts, 36 Anaganwadi centres were randomly surveyed to assess the electricity access gap. These included eight centres each in Dhanbad, Hazaribagh and West Singhum, and six each in Chatra and Ramgarh. These centres were collectively serving over 1,000 pre-school children through 60 caretakers (Anganwadi *didi*).

- Out of the 36 Anaganwadi centres surveyed, 23 were found to have grid-connection, while 13 were not connected to the grid. All randomly surveyed centres in Ramgarh had a grid connection, while one in Hazaribagh did not have a connection. Electrification gap was the highest in Chatra, Dhanbad and West Singhbhum at 83 per cent, 50 per cent and 38 per cent, respectively.
- The quality of power supply was reported to be low by the caretakers of all grid-connected centres, but with variations reported across districts. In Chatra, Dhanbad and West Singhbhum, the power supply during the hours of Anganwadi centre operations was reported to be as less at two hours, however it was higher at 3-4 hours in Hazaribagh and Ramgarh.
- The dependence on electrical equipment was witnessed to be very low – limited to one-two fans and one-four bulbs in grid connected centres. Only five Anganwadi centres had electric water pumps installed.
- Overall, the caretakers interviewed at these Anaganwadi centres reported the electrification experience to be unsatisfactory in Chatra, Dhanbad and West Singhbhum, while the experience in Hazaribagh and Ramgarh was reported to be satisfactory.
- Frequently reported issues due to the lack of power supply included low attendance in summer months due to the lack of cooling, and lack of proper water and sanitation facilities.
- Only 50 per cent of the surveyed Anaganwadi centres had water supply access. Only in Ramgarh, all the centres reported to have water available. Meanwhile, 83 per cent of the centres surveyed in Chatra, 63 per cent each in Dhanbad and Hazaribagh and 36 per cent in West Singhbhum did not have water availability.
- The gap in availability was also reflected in the rated experience of Anganwadi caretakers with respect to the availability of water for drinking and sanitation. Expect for Ramgarh, the majority response in all the districts was unsatisfactory.

Model Anganwadi center in West Singhbhum

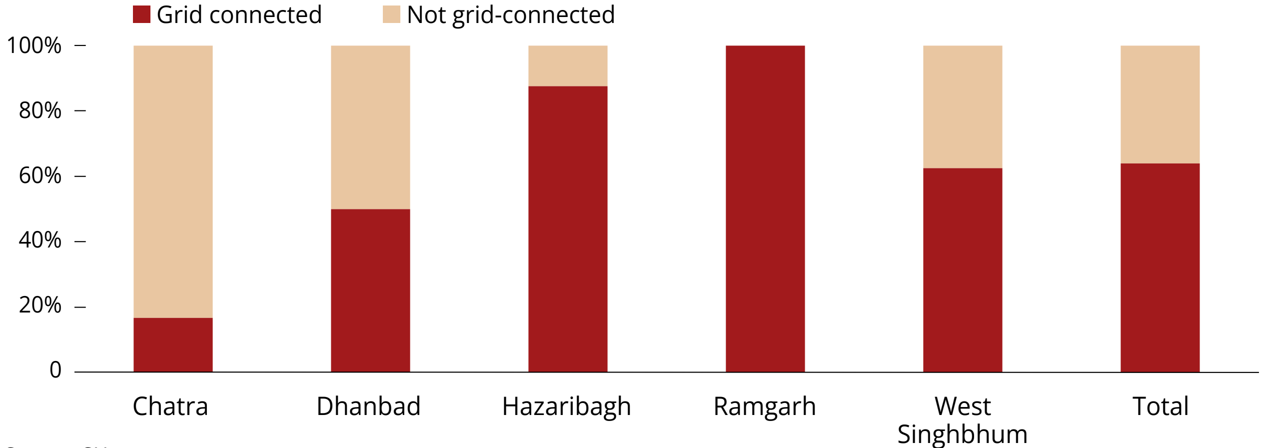
Dulu Ram, Surveyor

Figure 3.3: Details of surveyed Anganwadi centres in focus districts



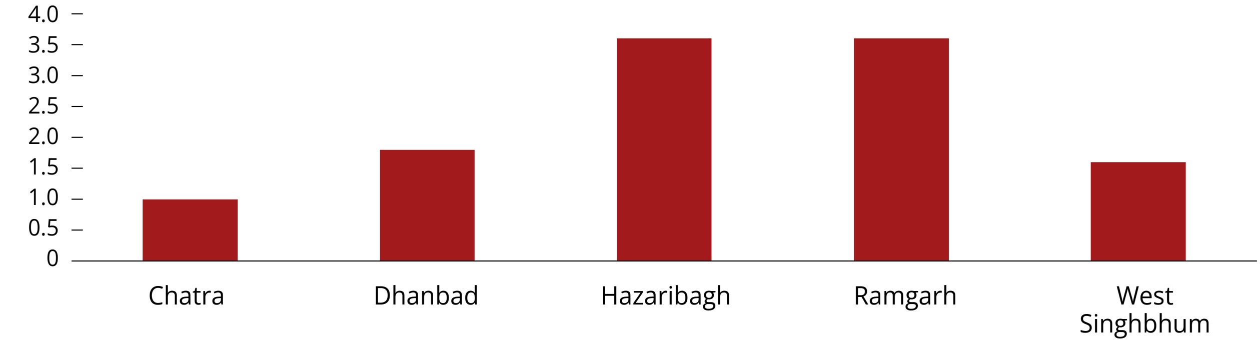
Source: SIA survey

Graph 3.4: Status of grid-connection at surveyed Anganwadi centres



Source: SIA survey

Graph 3.5: Power supply hours during operating times at surveyed grid-connected Anganwadi centres



Source: SIA survey

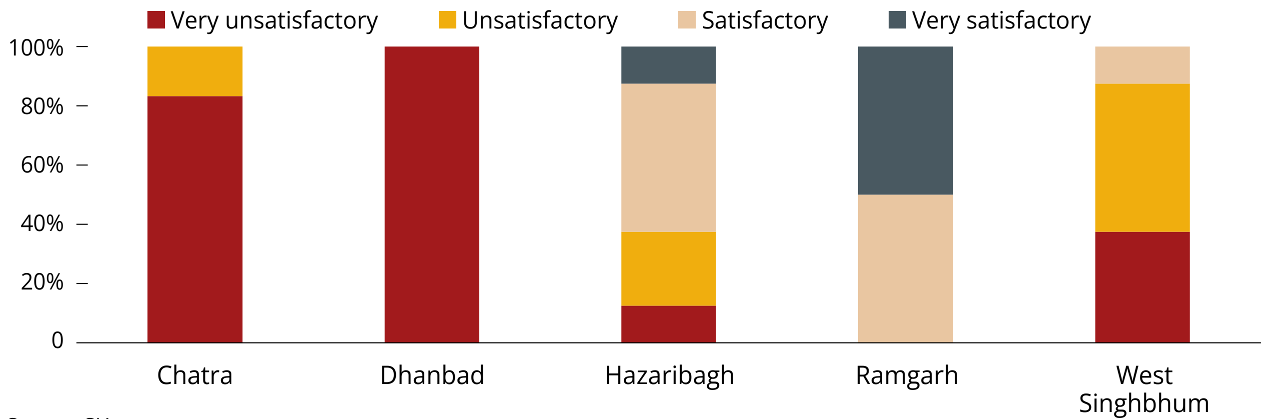
Figure 3.4: Electrical fittings/equipment available at Anganwadi centres

Average availability of one-two fans and one-four bulbs

14% of the centres had functioning electric water pumps

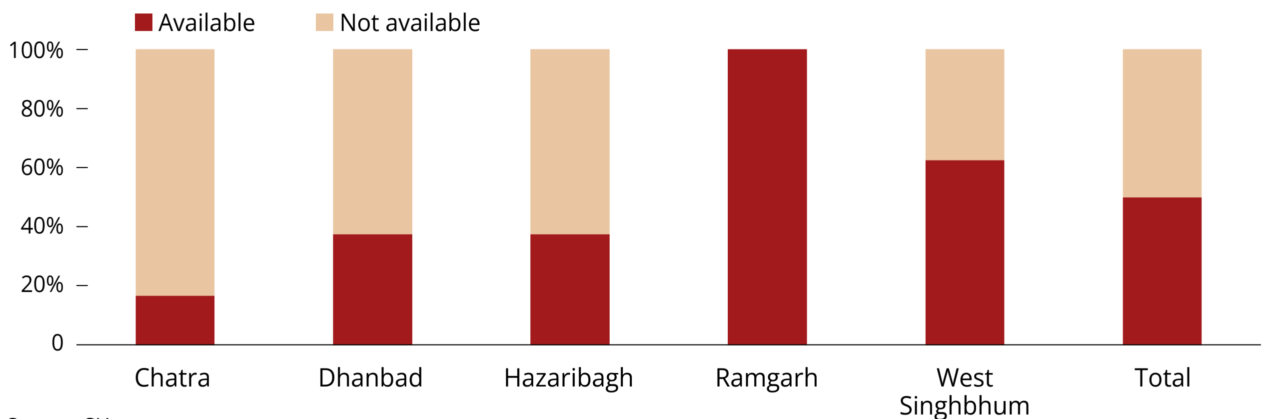
Source: SIA survey

Graph 3.6: District-wise rated experience with electricity access at surveyed Anganwadi centres



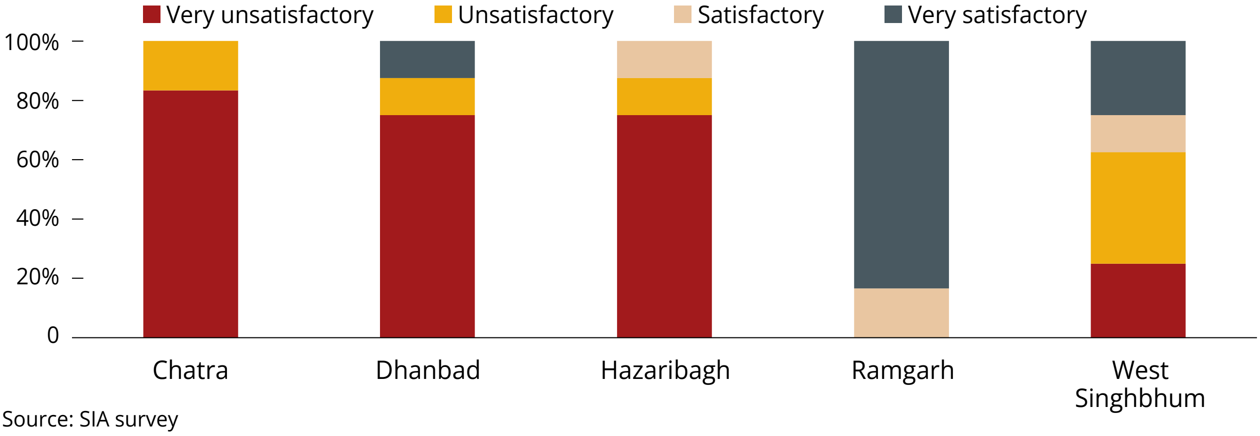
Source: SIA survey

Graph 3.7: Status of water availability at surveyed Anganwadi centres



Source: SIA survey

Graph 3.8: District-wise rated experience with water supply at surveyed Anganwadi centres



Source: SIA survey

3.3 SCHOOLS

Functional electrification and power supply continue to remain a challenge across all districts, creating a variety of operational challenges in delivering quality education

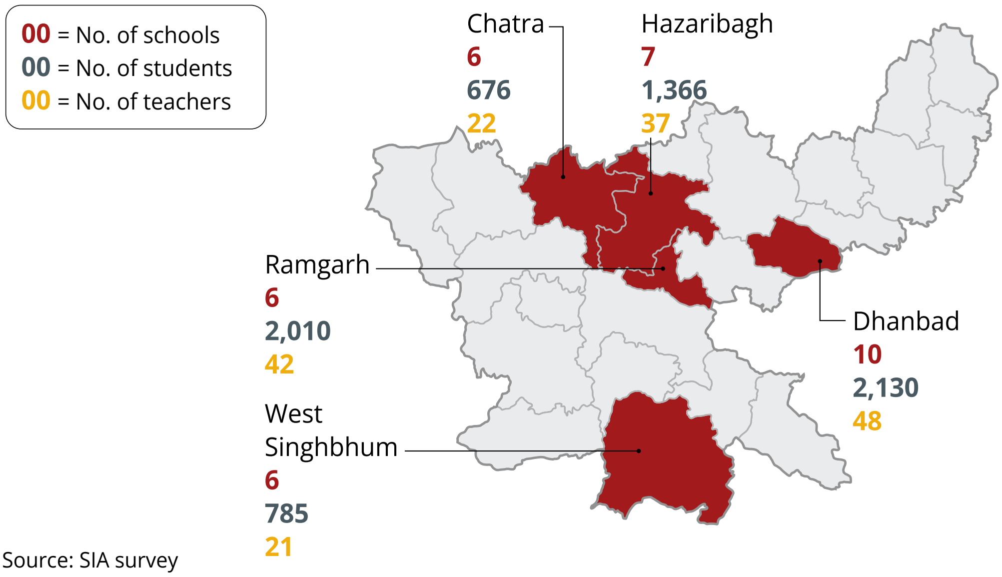
Thirty-five randomly selected public and private schools were surveyed in the five focus districts to assess the electrification gaps in the education sector. These included 17 primary schools, 12 upper primary schools, four secondary, and two higher secondary schools. Collectively, these schools were serving 6,967 students through 170 teachers. The sample included a wide range of schools with a student strength ranging from 35 to 600.

- Eighty-three per cent of the surveyed schools were connected to the grid, with six schools operating without a functional grid connection. These included two each in Chatra and Dhanbad, and one each in Hazaribagh and Ramgarh. None of the surveyed schools had diesel back-up.
- Twenty-five surveyed schools reported to have water availability from various sources, including pipeline, electric pump or handpump while 10 school reported no availability of water for drinking or sanitation.
- During the school hours – from 9 AM to 3 PM – the reported grid power supply averaged under three hours in Chatra, Dhanbad and West Singhbhum; and it was higher, at three-four hours, in Hazaribagh and Ramgarh.
- The penetration on electrical equipment remains very low. In schools with less than 100 students, an average number of five fans and five bulbs was reported to be in use. Fifteen bulbs and fans were in use for schools serving up to 400 students. Only two schools in Ramgarh reported to operating over 25 fans and bulbs. In addition, eight schools reported to have installed electric water pumps, and five schools had set up a projector. None of schools has computer labs or other digital education equipment.
- Nearly 66 per cent of the surveyed representatives from grid-connected schools reported to be facing regular operational challenges due to the lack of power supply, and 31 per cent reported to be facing occasional challenges. Other than Ramgarh where the respondents mentioned to be facing occasional to rare challenges, all the other four districts reported the challenges to be regular to occasional.
- The most frequently mentioned issue with grid power supply was unsuitable and inadequate supply hours in Dhanbad, Hazaribagh and West Singhbhum; infrequent power supply in Chatra and low voltage power supply in Ramgarh.

Primary school lacking electrification in Baghmara, Dhanbad

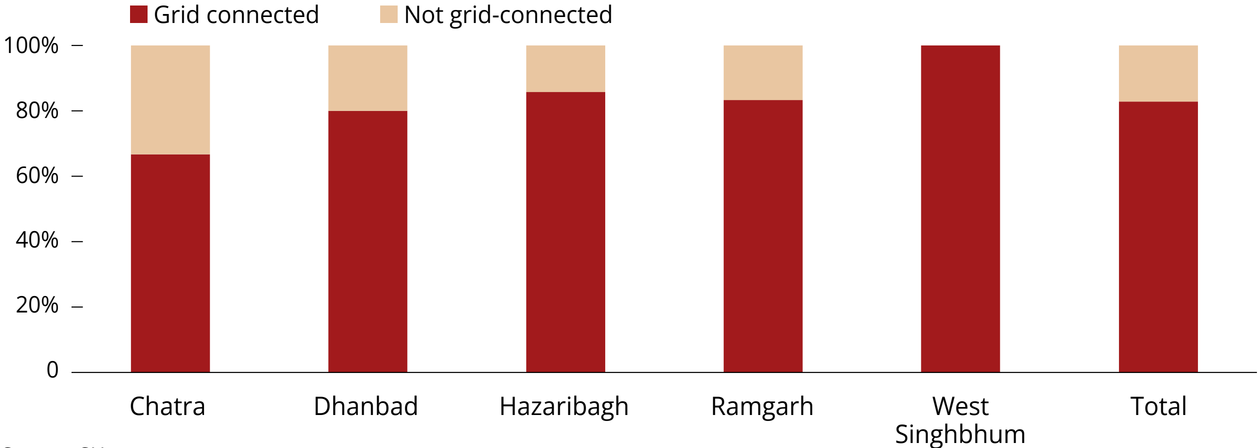
Ritwik Ray Chaudhuri, SIA

Figure 3.5: Details of surveyed schools in focus districts



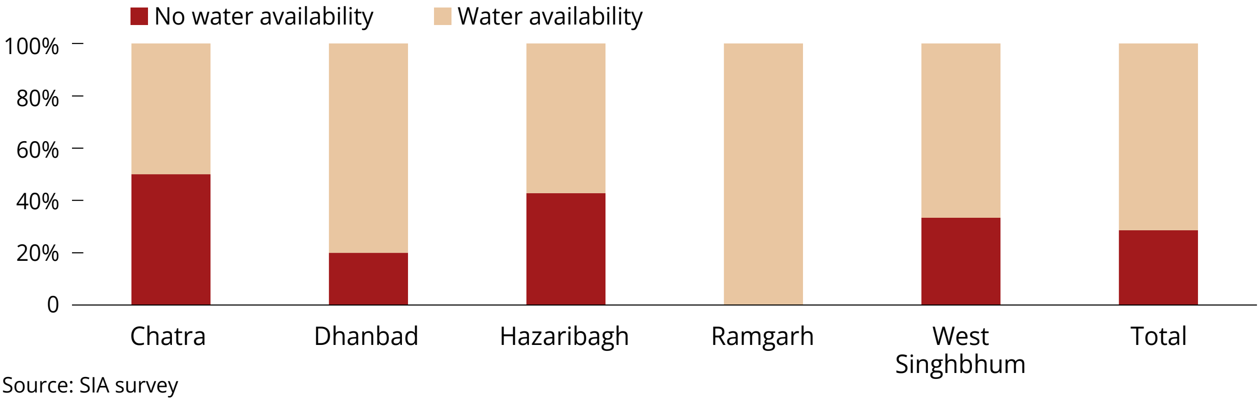
Source: SIA survey

Graph 3.9: Status of grid connection at surveyed schools in focus districts



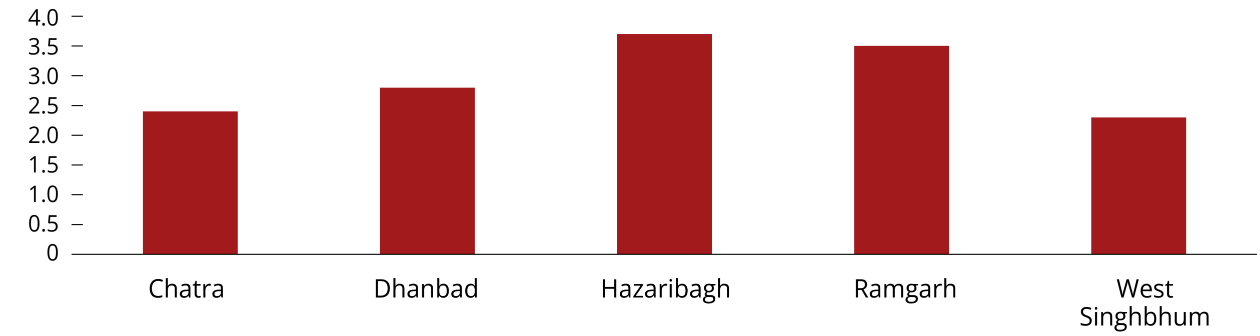
Source: SIA survey

Graph 3.10: Status of drinking water availability at surveyed schools



Source: SIA survey

Graph 3.11: Average hours of power supply during school hours at surveyed grid-connected schools



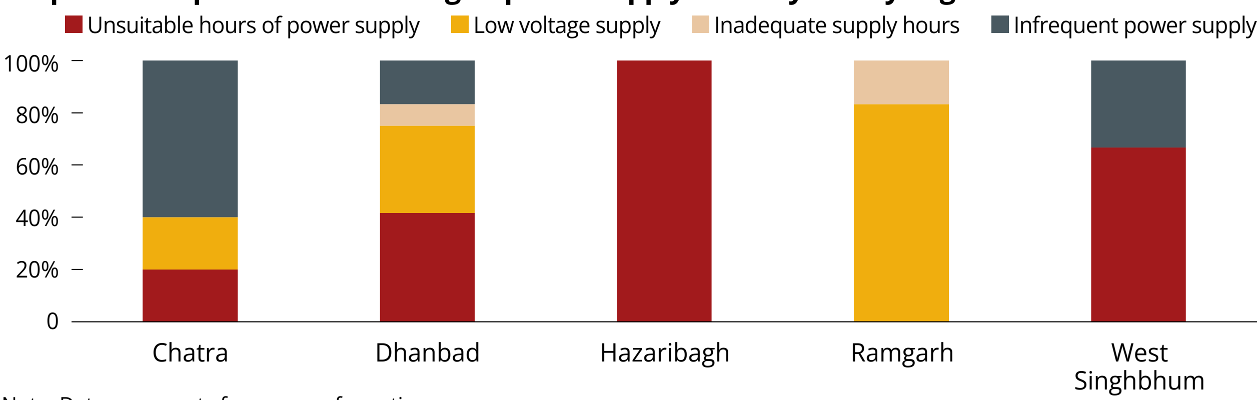
Source: SIA survey

Figure 3.6: Electrical fittings/equipment available at rural schools

Small schools	Large schools
Average availability of five fans and bulbs	Average availability of 15 fans and bulbs
20% of the schools had functioning water pump	25% of the schools had functioning water pump
One school had projector	Four schools had projector
None of the schools had computer labs	None of the schools had computer labs

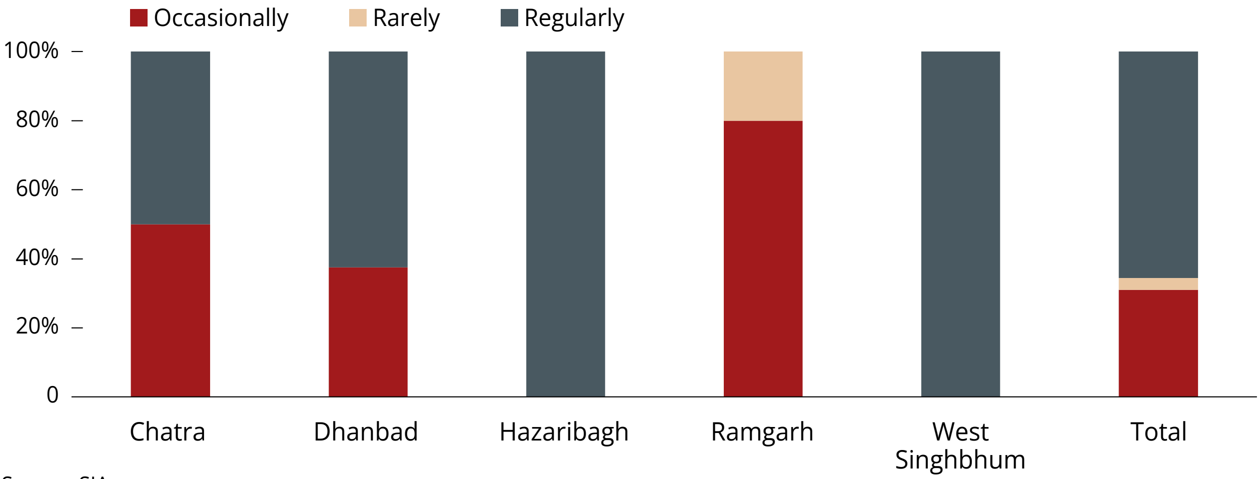
Source: SIA survey

Graph 3.12: Reported issues with grid power supply faced by surveyed grid-connected schools



Note: Data represents frequency of mentions
Source: SIA survey

Graph 3.13: Reported frequency of issues faced by surveyed grid-connected schools



Source: SIA survey

3.4 AGRICULTURE

While the access to irrigation remains very low in Jharkhand, for farmers with pumping access, high cost of diesel, limited reach of agriculture feeder, and low power supply quality remain major concerns; mechanisation of agriculture activities is low

The primary sector in Jharkhand, comprising agriculture and allied segments, contributes around 13 per cent towards the state's gross value added (GSVA), but provides employment to around 43 per cent of the workforce.[15] The output fluctuates considerably across years, with the year-on-year growth rates varying from a 30 per cent increase to a 28 per cent decrease, over the past decade. The output productivity is also low at 1,737 kilogram (kg) of food grain per hectare in 2019-20, against the national average yield of 2,386 kg per hectare.[16] This is primarily because nearly 80 per cent of the land area under agriculture remains under mono-cropping, of which 88 per cent is unirrigated land.[17]

Table 3.2: Share of mono-cropped land in Jharkhand ('00 hectare)

Farmer category	Irrigated mono-cropped land	Non-irrigated mono-cropped land	Total land under mono-cropping	Total area under cropping
Marginal	39,900	2,66,500	3,06,400	4,01,500
Small	26,200	1,74,200	2,00,400	2,59,600
Semi-medium	30,400	2,52,100	2,82,500	3,50,400
Medium	30,200	2,25,700	2,55,900	3,17,600
Large	21,500	1,75,700	1,97,200	2,18,400
Total	**1,48,200**	**10,94,200**	**12,42,400**	**15,47,500**

Source: All India Report on Input Survey 2016-17

Despite the efforts made under various government programmes, only 13.7 per cent of the total area under cultivation in Jharkhand is irrigated, against 52 per cent nationally. This includes 9.2 per cent area under cereal cultivation, 6 per cent area under pulses and 33 per cent area under oilseed cultivation. There is enough scope to build infrastructure to expand the reach of irrigation, as only 16 per cent of the total water resource available for utilisation has so far been tapped into.[18] The utilisation of surface and groundwater remains sub-optimal in Jharkhand.

Solarized Agri irrigation system through surface pumping, Dhanbad

Ritwik Ray Chaudhuri, SIA

Table 3.3: Share of irrigated area under crops in Jharkhand

	Area under cereals	Area under pulses	Area under oil seeds	Area under all crops
Jharkhand	9.2%	6.0%	33.3%	13.7%
All India	63%	23.2%	31.4%	52%

Source: Agriculture statistic at a glance, 2021

Table 3.4: Availability and utilisation of water resources for irrigation in Jharkhand (million cubic meters)

Category	Availability	Utilisation
Surface water	23,789	3,964
Ground water	4,992	772
Total	28,781	4,736

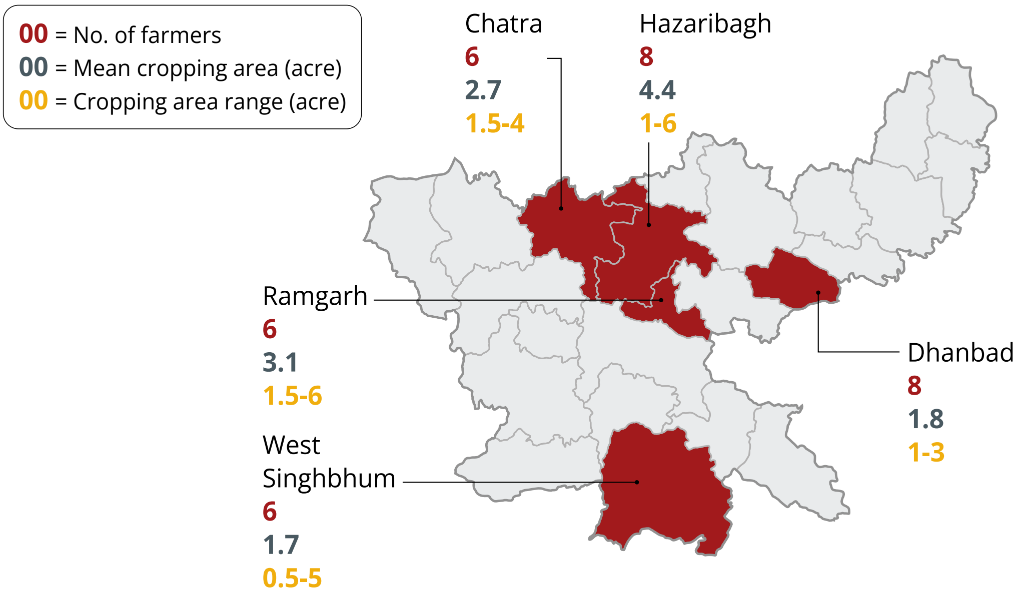
Source: Preparatory Survey on Initiative for Horticulture Intensification by Micro Drip Irrigation in Jharkhand, JICA

During the survey, 34 randomly selected pump-owning farmers were interviewed across the five focus districts to assess the issues being faced with diesel and electricity dependence. These included six farmers each from Chatra, Ramgarh, and West Singhbhum, and eight farmers each from Dhanbad and Hazaribagh. Of these, 56 per cent were marginal farmers with less than 2.5 acres of landholding, 38 per cent were small farmers with 2.5-5 acres, and six per cent were medium size farmers with over five acres of land.

- Nearly all surveyed farmers had access to some type of pumping equipment for irrigation and were thus engaging in at least double cropping during the year. All surveyed farmers were largely farming paddy during the kharif season, with three farmers also cropping maize. Wheat was reported to be the dominant crop for the rabi season, followed by vegetables and gram. Only six farmers reported to be cultivating during zaidi season, largely limited to vegetables and millets.

- Across the 34 farmers,19 diesel pumps and 20 electric pumps were reported to be used, including stacked usage with four farmers. Given the small land holding size of surveyed farmers, the mean pumping capacity was small, at around 2 HP, for both diesel and electric pumps.
- Half of the surveyed farmers were using submersible pumps and half were surface/shallow pumps. All surveyed farmers in Chatra owned submersible pumps, while all farmers in West Singhbhum employed surface pumps. Dominant surface water sources were reported to be surface tanks in Dhanbad and Hazaribagh, ponds in Ramgarh and, a mix of canal and ponds in West Singhbhum.
- Overall, the pumping requirement reported was on the higher side, at an average of four hours over 66 days in the kharif season, three hours over 60 days in rabi season, and three hours over 60 days in the zaidi season.
- Only one-third of the surveyed diesel using farmers reported to be facing regular operational issues with diesel pumps, however, all of the users mentioned the key concern to be the rising costs of diesel. As reported by diesel pump using farmers, the average monthly cost of diesel use stood at ₹4,500 per month.
- The reach of the dedicated agriculture feeder remains limited, as 60 per cent of the electric pump using farmers reported to be dependent on the one-phase village power line, and only the remaining 40 per cent had access to a three-phase dedicated agriculture feeder. The power on agriculture feeder line is reported to be available from 5 AM onwards for 2-3 hours and cost the farmers ₹350-₹600 per month.
- Irregular power supply and low voltages was a concern for electricity pump users dependent on domestic power line, while inadequate supply hours was a key concern for agriculture feeder dependent farmers.
- Beside pumps for irrigation, four surveyed farmers reported to be using drip irrigation systems, including one system being run on electricity and three on diesel. No other major electrical equipment was reported to be used besides electric pumps.

Figure 3.7: Details of surveyed farmers in focus districts



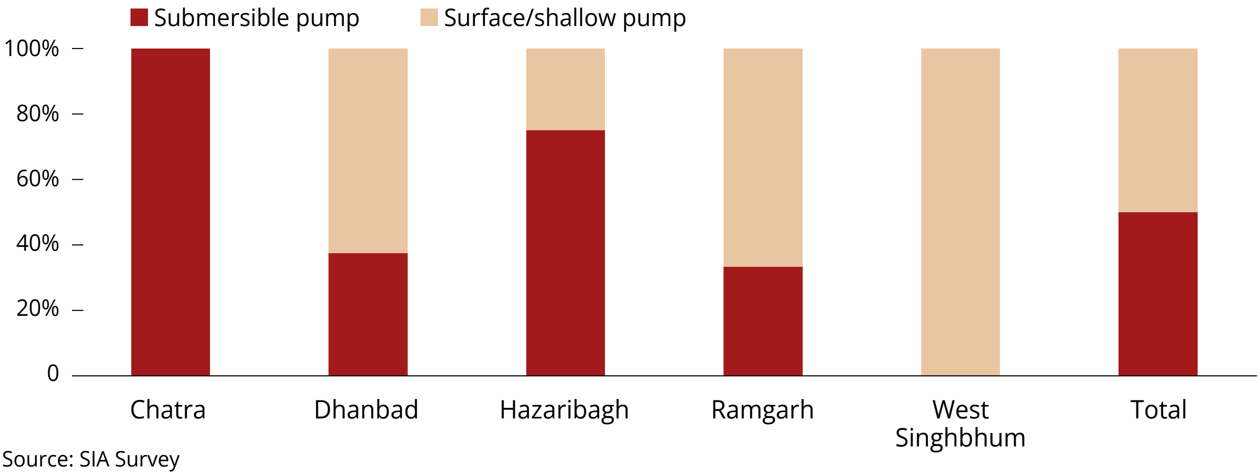
Source: SIA Survey

Table 3.5: Pump dependence and copping intensity of surveyed farmers

District	Pump ownership				Cropping intensity	
	No. of diesel pumps	Mean pump capacity (HP)	No. of electric pumps	Mean pump capacity (HP)	Two times	More than two times
Chatra	6	2.8	1	2.0	6	
Dhanbad	6	1.5	2	4.8	5	3
Hazaribagh	2	1.5	7	2.0	8	
Ramgarh	3	1.0	4	1.3	5	1
West Singhbhum	2	1.0	6	2.7	4	2
Total	19	1.7	20	2.3	28	6

Source: SIA Survey

Graph 3.14: Pump type employed by surveyed farmers



Source: SIA Survey

3.5 AGRI-BASED MICROENTERPRISES

Despite improved electrification, the dependence on diesel equipment remains high across all districts which is restricting the profitability and scalability of businesses

Thirty-five agriculture-related microenterprises were surveyed in the five focus districts to assess their dependence on electricity. These included 14 poultry units, 10 *chakki* (grinding) units, five rice hullers, three fisheries and one each of dairy, millet processing and timber mill units. Most of these were new enterprises, with 23 units reported to be set up in the past decade. The surveyed units were of varying sizes, including 10 units doing a business of less than 50 kg daily, another 10 units with up to 100 kg daily and 12 units with up to 500 kg daily.

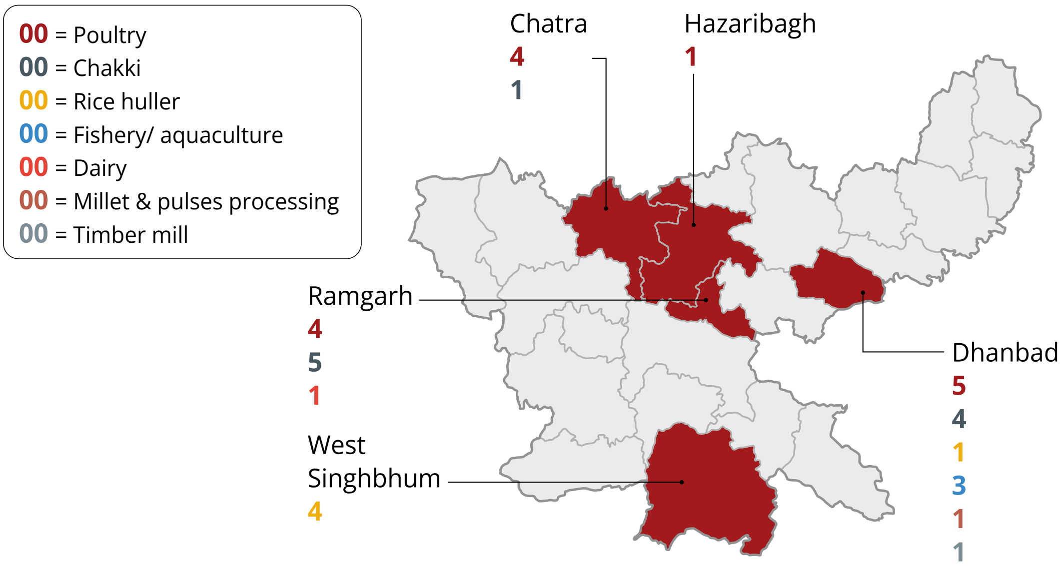
- Of the surveyed 35 microenterprises, 31 had grid power connections while four units were not connected to the grid. The unconnected units were located in Dhanbad and West Singhbhum. Three of the surveyed units had power back-up in the form of batteries mostly for servicing the requirement of light and fan.
- While 90 per cent of the surveyed units were connected to the grid, their dependence on diesel remained high. Diesel was being used as a primary energy source by nearly 50 per cent of the surveyed units, grid power by 44 per cent, and petrol by six per cent.

Grid-connected Agri-food processing (atta chakki), Gola

Arpo Mukherjee, SIA

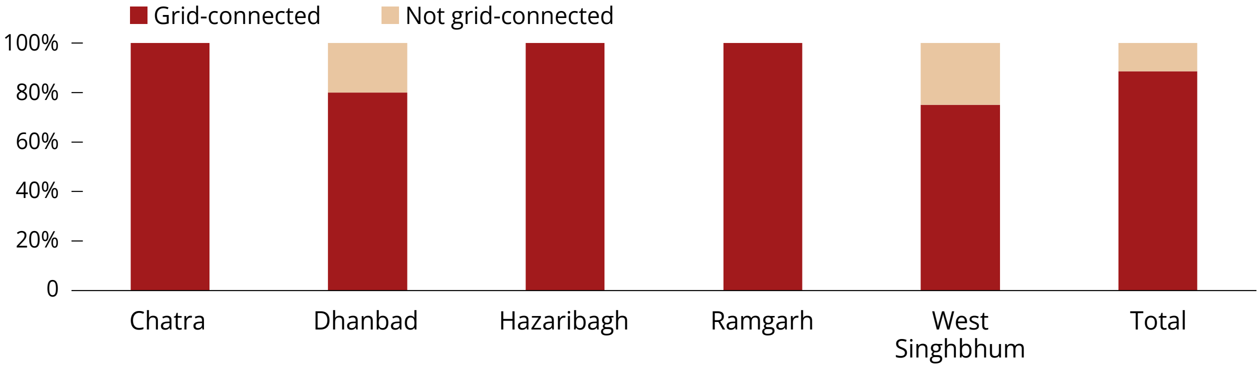
- Typically, diesel is used to run all grinding, hulling, processing, and fishery-related activities, while grid power is primarily relied on by poultries.
- Low quality and irregular power supply is responsible for the heavy reliance on costly diesel fuel. According to the surveyed microentrepreneurs, the average hours of power supply in Chatra, Dhanbad and West Singhbhum was 5-10 hours in a day, while it was reported to be 12-14 hours in Hazaribagh and Ramgarh. This included a low voltage power supply for 15-33 per cent of the time.
- In terms of the key operational issues faced due to the source of energy, the most commonly flagged concern was the rising cost of diesel (mentioned as a key concern by 32 per cent of the respondents), followed by infrequent power supply (22 per cent), inadequate power supply (20 per cent), low voltage power supply (15 per cent) and difficulty in procuring diesel (11 per cent).
- The lack of reliable and cheap energy sources was flagged as a key concern for scaling up operations and improving productivity.

Figure 3.8: Details of surveyed agri-based microenterprises in focus districts



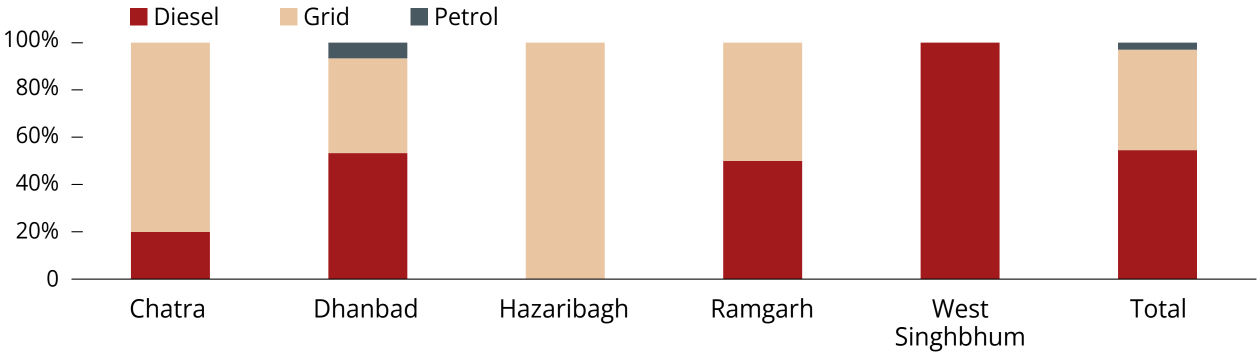
Source: SIA Survey

Graph 3.15: Status of grid connection at agri-based microenterprises in focus districts



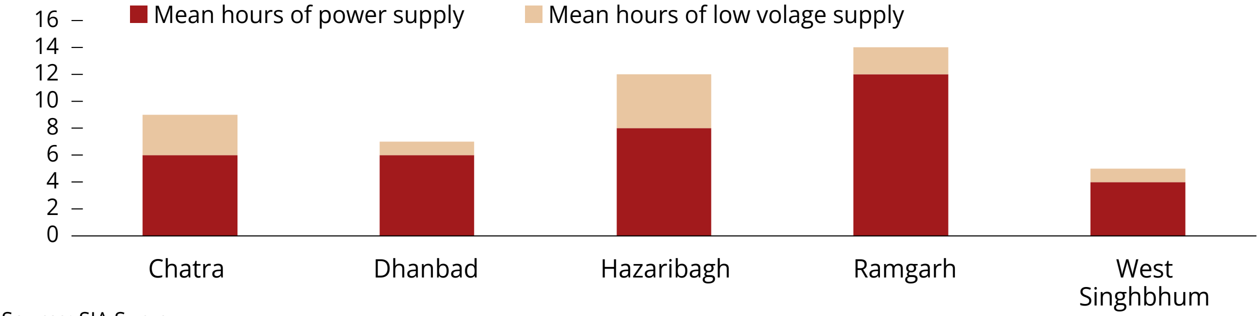
Source: SIA Survey

Graph 3.16: Source of energy for powering equipment at agri-based microenterprises



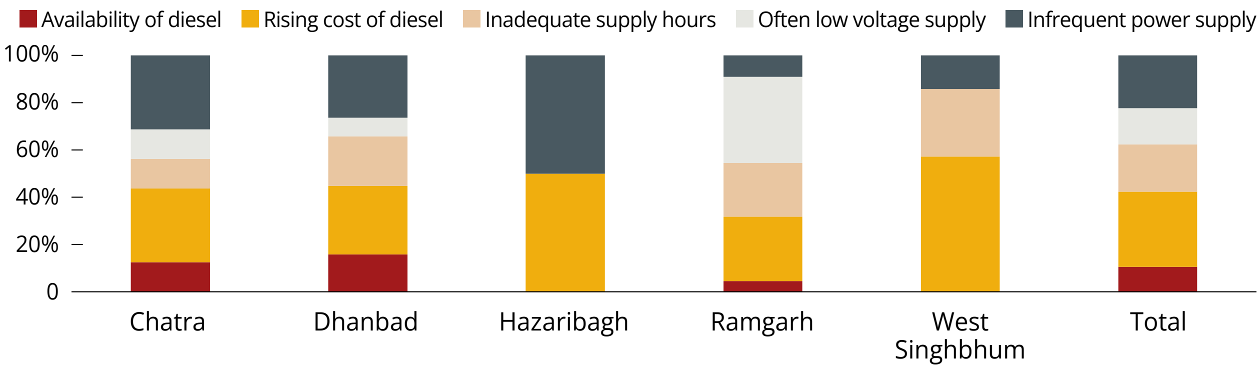
Source: SIA Survey

Graph 3.17: Average power supply situation scenario at surveyed microenterprises



Source: SIA Survey

Graph 3.18: Key issues with electricity/diesel use flagged by surveyed microenterprises



Source: SIA Survey

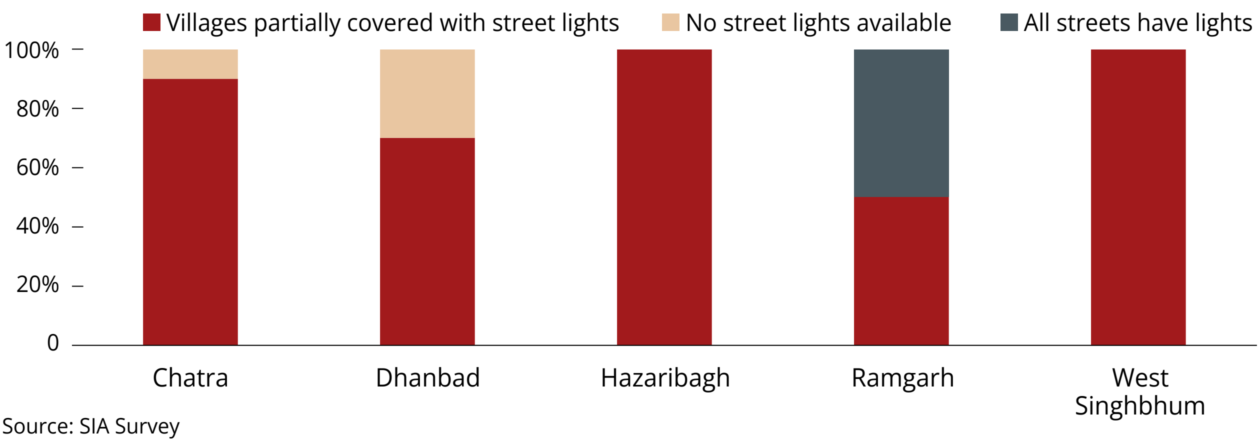
3.6 COMMUNITY LIGHTING

Expanding reach due to past and ongoing investments across all districts; adequacy of power supplies a key concern in delivery of services

Twenty-nine panchayat representatives were surveyed, representing 190 villages, to inquire about the gaps in community level lighting. Aligned to household electrification, the street lighting has improved in rural areas.

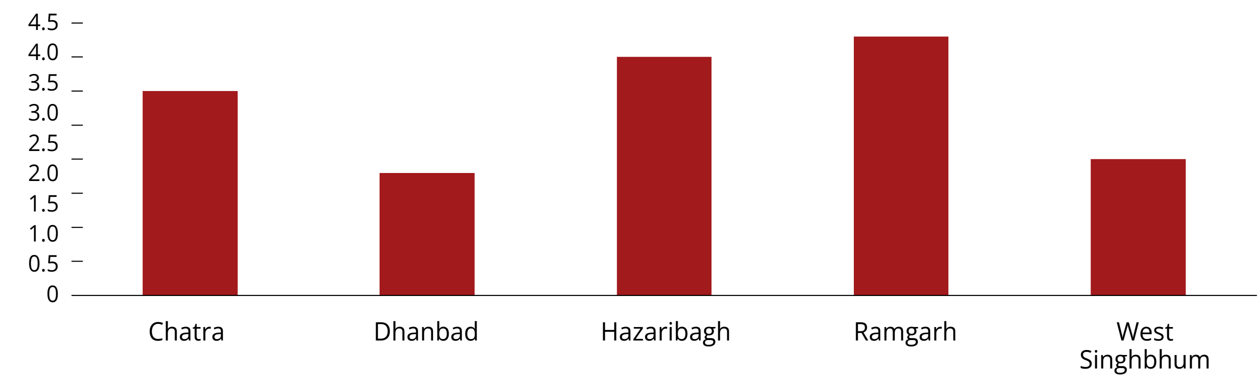
- Nearly 80 per cent of the surveyed panchayat representatives reported partial availability of streetlights in all the villages, including lights installed at one or two strategic locations or in the main streets. Of the remaining, about 10 per cent of the panchayats located in Chatra and Dhanbad indicated that there were no streetlights available in villages; while another 10 per cent located in Ramgarh mentioned that all the street largely had streetlights.
- Overall, the key challenge pertained to the operations of the streetlights due to the gaps in grid power supply. In the surveyed panchayats, grid power supply was reported to range from 6-18 hours, with Chatra, West Singhbhum and Dhanbad experiencing lower supply hours.
- As such the experience with community lighting was reported to be lowest in these districts. On a scale of one to five, with one being the lowest level of satisfaction and five being highest, the average rating of panchayats surveyed in Dhanbad and West Singhbhum was under two, while that of Chatra was three, Hazaribagh 3.5 and Ramgarh was highest at 3.8.

Graph 3.19: Availability of community lighting facilities in surveyed panchayats



Source: SIA Survey

Graph 3.20: District-wise rated experience with community lighting at villages



Note: One signifies lowest level of satisfaction and five signifies the highest

Source: SIA Survey

Solarized drinking water system through piped supply, Dhanbad

Ritwik Ray Chaudhuri, SIA

3.7 WATER SUPPLY

Massive ongoing investments in DMF districts have been reported. Solar-based water supply systems performing well; power supply a key concern in delivery of services by grid-connected projectss

In the last five years, major investments have been made in centralised water supply schemes in the key mining districts in Jharkhand. Most of these investments have been supported by DMF funds. In fact, over 75 per cent of the sanctioned amount from DMFs of all the five focus districts have been in drinking water supply schemes (refer to section 5.1 for details).

However, the surveyed panchayats could not provide a clear picture of the reach of piped water supply, as a number of schemes are still ongoing and will take few years before piped water reaches all the intended villages. From the indicative survey, three key messages emerged:

1. Water supply through pipelines and solar *Jal Minars* (solar-powered drinking water towers) are expanding rapidly.
2. In villages where water is supplied through pipelines from grid-connected projects, the duration of supply is limited, ranging from 0.5-3 hours, typically once a day. One panchayat in Dhanbad reported to be receiving water only for 2-3 days in a week.
3. As of today, water supply through traditional modes of well and handpump continued to play a dominant role in household water supply. A similar picture is indicated by the data available at the Jal Jeevan Mission database.

Table 3.6: Access to piped water supply in focus districts

District	Share of schools with piped water supply	Share of Anaganwadi centres with piped water supply	Share of households with tap water access
Chatra	2%	0%	15%
Dhanbad	35%	15%	29%
Hazaribagh	24%	0.2%	15%
Ramgarh	24%	8%	51%
West Singhbhum	26%	1%	19%

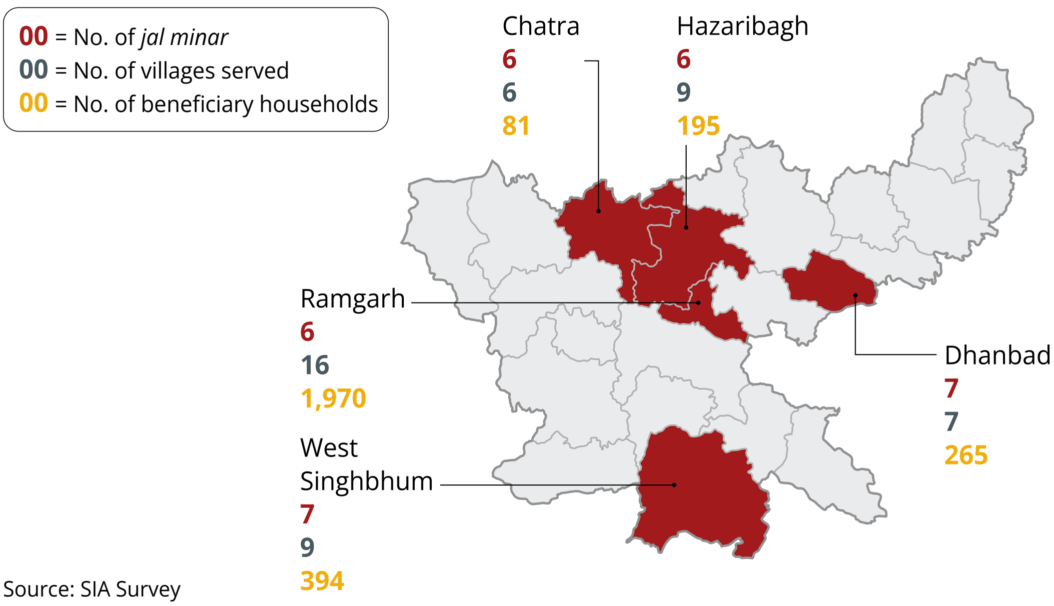
Source: Jal Jeevan Mission India portal, accessed May 2022

3.7.1 Solar *Jal Minars*

Nearly all panchayat visited in the focus districts had community solar *Jal Minars* (water towers) set up to address the issue of drinking water availability in the villages. SIA interviewed the beneficiaries of 32 *Jal Minars* located across different panchayats, including six in Chatra, seven in Dhanbad, six in Hazaribagh, six in Ramgarh and seven in West Singhbhum. All of these systems have been installed with a 100 per cent subsidy through financing from DMF or Finance Commission or panchayat or by CSR funds.

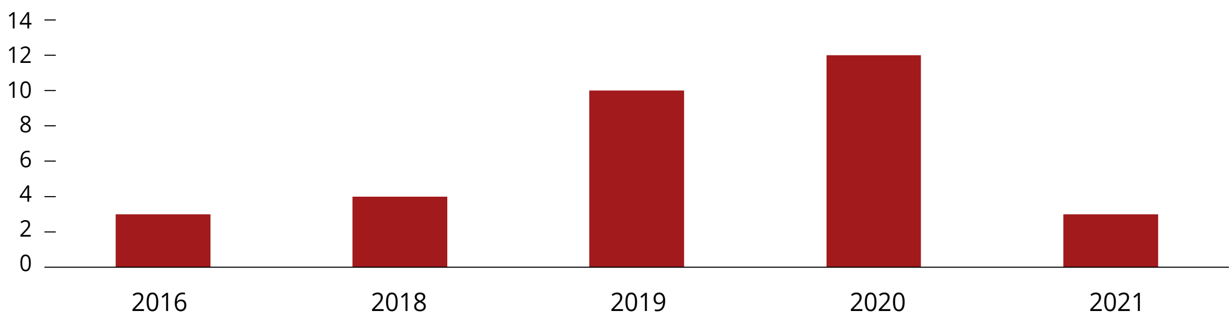
- The surveyed 32 solar *Jal Minars* were collectively serving 47 villages and 2,905 households. Each *Jal Minar* was serving on an average 90 households.
- Three-fourths of these *Jal Minars* had 1 HP DC pumps installed will three solar panels, while one-fourths had 2 HP DC pumps with six panels.
- These systems are typically accompanied by 2,000 litres tanks and an automatic controller that switches on the pump when the water level in the pump drops. The pump operates 1-3 times during the day to fill the tank, to ensure 6-8 hours of drinking water availability.
- These systems had been put up in the last five years, but varying frequencies of operational problems were reported. While 22 per cent of the surveyed pumps were reported to have never faced any operational breakdown, 38 per cent rarely faced issues, 25 per cent occasionally faced issues, while the remaining 15 per cent regularly faced breakdowns. The types of reported challenges included glitches in water pipes, control panels and pumps.
- Overall, beneficiaries reported a high level of satisfaction with the performance and service delivery of *Jal Minar*.

Figure 3.9: Details of surveyed solar *Jal Minars* in focus districts



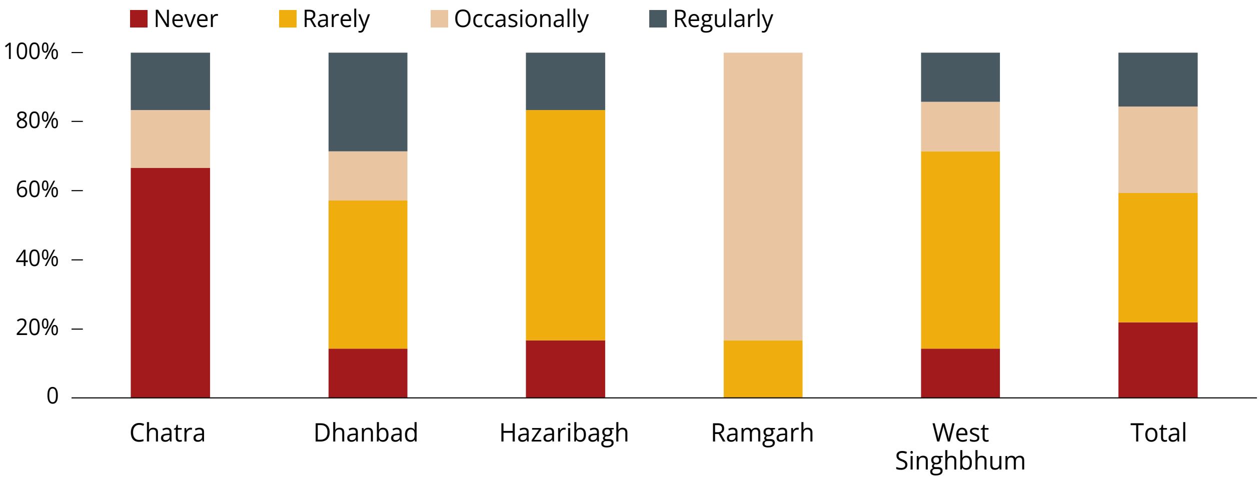
Source: SIA Survey

Graph 3.21: Year of installation of surveyed solar *Jal Minars* in focus districts



Source: SIA Survey

Graph 3.22: Frequency of operational challenges faced with surveyed solar *Jal Minars*



Source: SIA Survey

3.8 CONCLUSION

The rural power situation in Jharkhand appears to have improved in the recent years, but there is still a gap in achieving universal electrification, and the quality of supply remains a chronic problem. Functional electricity connection is a big concern due to the gaps in repair and maintenance of the distribution network. Biggest gaps in electrification/functional electrification exist in social infrastructure segments. At the time of the survey visit, 36 per cent of the surveyed Anganwadi centres, 23 per cent of health centres and 20 per cent of schools did not have electricity connection or a functional electricity connection. Electrification gaps are highest for farmers, as a vast majority remain rainfed or diesel dependent.

There are basic challenges of lighting, cooling and water supply which render operations of social infrastructure difficult and, at times, unviable. In addition, the emerging requirements of medicine/vaccine storage in health centres and computer education in schools, which are necessary in today's times, cannot be provided due to the erratic power supply.

In the primary sector, the power supply gap has resulted in low levels of mechanisation and continued high dependence on costly and expensive diesel both, in farming, and in microenterprises. The survey found nearly half of the farmers and half of the micro-entrepreneurs to be diesel-dependent and struggling with the issues of rising diesel costs. This affects both the profitability of farming/business operations as well as scalability.

Addressing the energy requirements of social infrastructure, farmers and micro-entrepreneurs is crucial for the reduction of multi-dimensional poverty in rural Jharkhand. It is particularly important to address the energy issue, as large sums of money are being spent on building community infrastructure, which could lead to sub-optimal outcomes in the absence of a reliable power supply.


Arpo Mukherjee, SIA

4. SCOPE OF SOLARISATION ACROSS KEY SECTORS

Bridging the energy access gap is fundamental to economic growth and societal development. Recent expansion of the power grid in rural Jharkhand has not delivered optimal results due to many inadequacies. The state continues to struggle with ensuring functional electrification and ensuring supply deficits due to institutional inefficiencies of Jharkhand Bijli Vitaran Nigam Limited (JBVNL), the state distribution company. Improving energy access through the grid requires a multi-year and multi-crore effort to implement broad-based structural reforms that improve network strength, procurement planning, billing, metering, and collection etc. However, past efforts by the Ministry of Power, Government of India, through schemes like the Ujwal Discom Assurance Yojana (UDAY), have not managed to usher sweeping changes. In this scenario, distributed renewable energy (DRE) has been steadily helping to bridge the energy access gap in the state. Implementation of such solutions in key sectors like nutrition, health, education, water supply, livelihoods etc. can contribute significantly to community welfare and prosperity, while supporting greening of the grid.

4.1 SOLARISATION OF NUTRITION AND HEALTH

Jharkhand's underwhelming performance on health and nutrition parameters is well established by various national and state-level enquiries. NITI Aayog's Health Index developed for 2019-20 assigns Jharkhand a score of 47.55 out of 100, categorising it as an aspirant state with substantial scope for improvement, and ranking it among the bottom one-third states.[19] Relative to the 2018-19 index, Jharkhand reported only a moderate improvement of 3.38 points in 2019-20. The recently published National Family Health Survey in 2019–21 (NFHS-5) by the Ministry of Health and Family Welfare, also points to consistent improvements in health and nutrition outcomes, but there remains a vast scope for improvement.

The NFHS-5 indicates that nearly 62 per cent of the state's population does not generally use government health facilities. Among other listed reasons, 'poor quality of care' is quoted to be the prime reason by 47 per cent of the households for not using these government facilities.

Table 4.1 Key health and nutrition indicators for Jharkhand

Indicators	2005-06	2015-16	2019-21	All India (2019-21)
Infant Mortality Rate (per 1,000 births)	69	44	38	35
Under-Five Mortality Rate (per 1,000 live births)	93	54	45	42
Stunted children under the age of five years	50%	46%	40%	36%
Prevalence of anaemia among children	70%	70%	67%	67%

Source: National Family Health Surveys

4.1.1 Role of electricity access

The electricity assess gap is a crucial contributor to poor quality health care. According to the Rural Health Statistics 2020-21, 13.5 per cent of sub-centres and 13.4 per cent of the primary health centers (PHCs) in Jharkhand do not have electricity connections. However, SIA survey reveals the challenge to be more pronounced with functional electrification missing at a higher share of health centres, and power supply gaps ranging from six hours to even 18 hours daily. Without regular and reliable power supply, healthcare services are significantly compromised even with the availability of infrastructure like labour rooms, vaccine freezers and skilled staff.[20]

Table 4.2: Infrastructure availability at rural health centres in Jharkhand

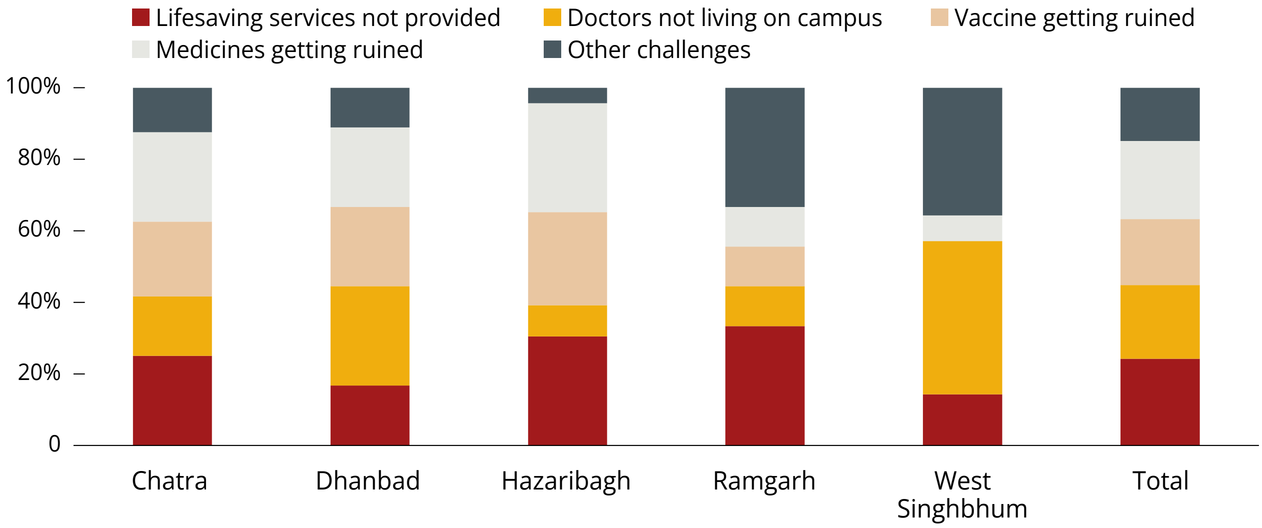
Rural sub-centres		Rural PHCs	
Total	3,848	Total	291
Sub-centres with ANM quarters	1,782	PHCs operating 24X7	216
Sub-centres without electric supply	518	PHCs without electric supply	39
Sub-centres without regular water supply	828	PHCs without regular water supply	40

Source: Rural Health Statistics, 2020-21

During the SIA survey of 30 health centres , lack of adequate and reliable power supply to hospitals was indicated to be linked to a number of crucial healthcare gaps. The most frequently mentioned issue was that of medicines and vaccines getting ruined (40 per cent), lifesaving services not being provided (24 per cent), and doctors not living/coming to the campus (21 per cent). The remaining concerns (15 per cent) pertained to specific issues of non-functional operating theatres, lack of maternity services, lack of x-ray facilities, lack of cooling during summers, drinking water and sanitation gaps, and no provision of emergency and night-time services.

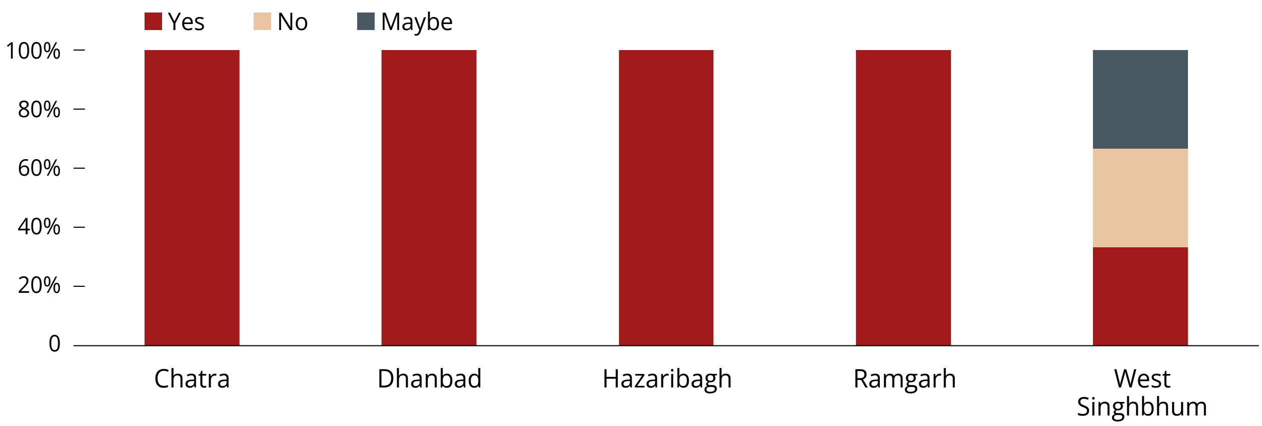
An overwhelming majority of the surveyed healthcare representatives (87 per cent) believed that improved electricity supply can lead to better healthcare services. In fact, when asked to list key changes that can help improve healthcare services in the district, ensuring regular electricity supply was the most frequently quoted answer along with ensuing medicine availability, followed by ensuing the availability of doctors, medicine and vaccine storage and water supply.

Graph 4.1: Key issues faced due to lack of adequate power supply at surveyed health centres



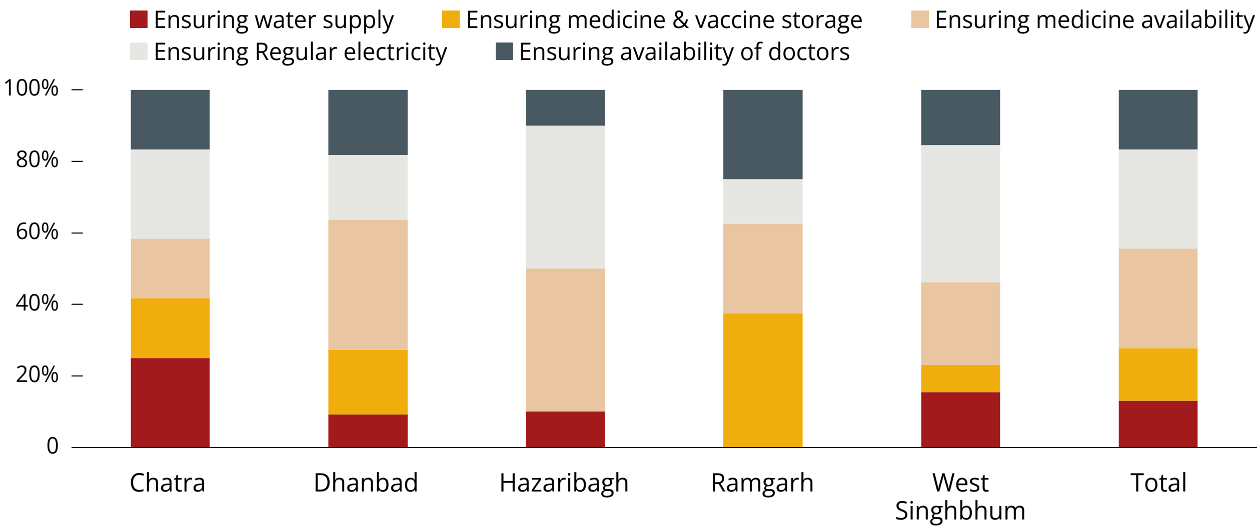
Note: Data reflects frequency of the challenges mentioned by surveyed health centre representatives.
Source: SIA survey

Graph 4.2: Potential of improved electricity supply in improving healthcare services



Note: Data reflects perception of surveyed health centre representatives
Source: SIA survey

Graph 4.3: Key areas to improve quality in health services in Jharkhand



Note: Data reflects perception of surveyed health centre representatives.
Source: SIA survey

4.1.2 Solar for health centres

At present, the available electrical infrastructure at the health centres in Jharkhand is grossly lacking relative to the guidelines for PHCs and sub-centres identified by the Indian Public Health Standards in 2012. This can be improved by solarisation of the health centres.

Figure 4.1: Electricity dependent facilities and equipment required at PHCs and health sub-centres

PHCs

- Lighting and fan
- Room heater/cooler
- Refrigerator
- ECG Machine
- Fully equipped labor room
- Radiant warmer for new born baby
- Computer
- Public address system
- 24x7 water supply
- Power backup
- X-ray machine*
- Ventilator*
- Overhead projector*

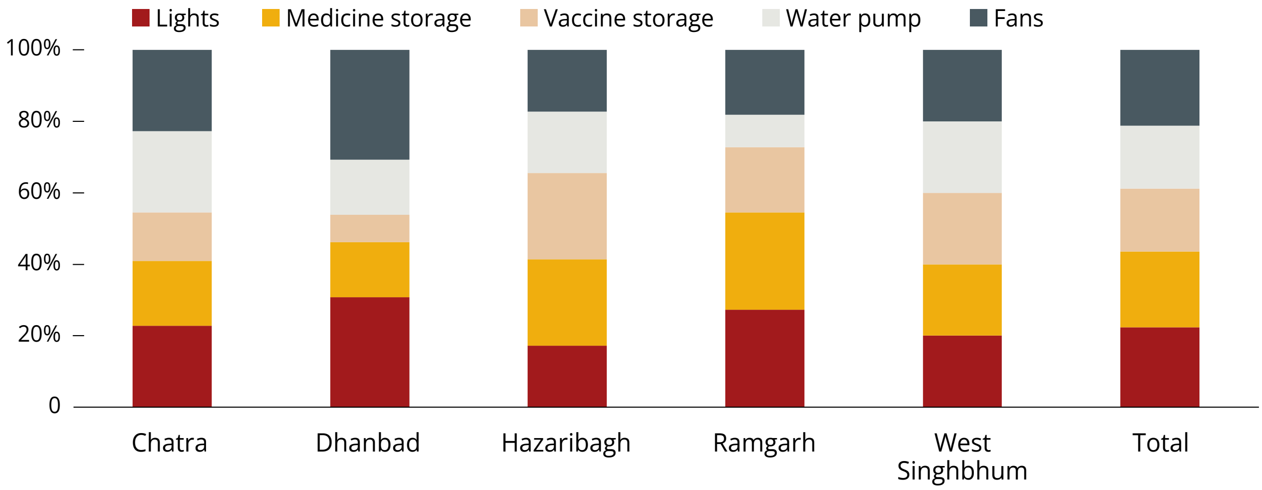
Sub-centres

- Lighting and fan
- Room heater/cooler
- Refrigerator*
- 24*7 water supply
- Power backup*
- Computer*

*Optional
Source: Based on Indian Public Health Standards (IPHS) Guidelines for Sub-Centres, 2012; Indian Public Health Standards (IPHS) Guidelines for Primary Health Centres, 2012

Smaller solar-based applications are available that can help address individual and specific requirements of lighting, pumping, or cooling required at health centres. However, it would be appropriate to provide a comprehensive solution that covers all these requirements, as reflected in the survey. When health centre representatives were asked to prioritise equipment for solarisation for improving health care services, the response was almost evenly spread out across lights, fans, medicine storage, vaccine storage and water pumps.

Graph 4.4: Priority for solarisation of equipment for health centres



Note: Data reflects perception of surveyed health centre representatives
Source: SIA survey

SOLARISATION OF HEALTH CENTRES IN JHARKHAND

The Jharkhand Renewable Energy Development Agency (JREDA), in collaboration with the state health department has been installing solar panels at rural health centres to cover the energy access gap. The agency had initially solarised nine community health centres on a pilot basis, following it with identifying a larger plan of solarising district hospitals, CHCs and PHCs with 2-4 kW solar systems to at least store medicines and vaccines.[21] Sub-centres are yet to be brought under a comprehensive solarisation plan.

During the SIA survey, seven health centres were visited that had installed solar panels of varying capacities for varying purposes. The seven health centres included four PHCs, two sub-centres and one CHC located in Chatra, Dhanbad, Ramgarh and West Singhbhum. These included three locations where 3 kWp systems were installed to serve a 2 HP pump, lights and fans, and four locations where a 1 HP solar water pump was installed. The key observations from the survey are as follows:

- Since these were mostly recent installations, put up in the past three years, the frequency of operational challenges was reported to be low. The majority of the solar water pumps (three out of four) had never faced breakdowns since installation. In the case of rooftop installations, the three health centres reported to be facing occasional to rare maintenance issues, primarily pertaining to batteries. There were concerns also about sizing as well because the installed system was not able to generate adequate power for meeting the demand.
- As per the perception of health centre representatives, the solarisation led to moderate to significant improvements in the quality of services delivered, primarily because of the partial nature of services being covered. There was a unanimous demand for the installation of solar panels for meeting the comprehensive energy demands of health centres and bringing more services under solarisation.

Covering basic services of lighting, cooling and water supply has merit because of the massive existing deficit and budgetary constraints, however, incomplete solarisation leads to suboptimal outcomes as far as improvements in service quality are concerned.

Proposed specification and costs

a. Health sub-centre

At present, the power requirement for a health sub-centre is small at about 2-4 bulbs and fans, and one small water pump, while provision of a freezer for medicines and vaccines storage is not mandatory. About a quarter of the sub-centres surveyed by SIA had fridge available.

For a typical sub-centre with four bulbs, two fans, one water pump and one freezer, the peak load requirement adds up to 1.4 kW. Power back-up of varying capacities would be required to ensure 24 hours of freezer operations depending on the district and block grid-power scenario. For districts like Chatra and West Singhbhum, power back up of up to 12 hours can be planned to support night time operations, while in Ramgarh and Hazaribagh the planned support could be for six hours.

Option 1: A rooftop solar installation of 2 kW would be optimally suited to support the requirement, along with a battery support of 600 Ah to 150 Ah depending on the hours of back-up supply required. If the requirement of freezers is removed at health sub-centres, the system size requirement is reduced to 1.5 kW with a battery of 150 Ah capacity for a four-hour back-up. Depending on the various configurations, the cost of installations varies between ₹1,00,000 and ₹1,50,000.

Option 2: An alternate solution for health sub-centres would be to install 1 HP DC pumps with USPC, which would also supply power for operating the lights and fans. Such a system would cost up to ₹1.25 lakh. A solar freezer can be additionally procured at a cost of about ₹40,000 for a 100-litre system.

Table 4.3: Consumption load and solar capacity requirement at health sub-centres

Load details	Category	Optimum system	Cost (₹)
• 4 bulbs of 20 W • 2 fans of 50 W • 1 HP water pump • 1 freezer of 100-litre capacity	With freezers	• 2 kW solar grid-connected system with 2 kW (24V) hybrid inverter capacity • 600 Ah (150x4/300x2) (12V) battery capacity for 12 hours of backup	1,44,000
		• 2 kW solar grid-connected system with 2 kW (24V) hybrid inverter capacity • 300 Ah (150x2/75x4) (12V) battery capacity for six hours of backup	1,27,000
		• 1 HP DC solar water pump with USPC to support light and fan load • 100-litre solar freezer	1,40,000
	With-out freezers	• 1.5 kW solar grid-connected system with 2 kW (24 V) hybrid inverter • 150 Ah (75x2) (12 V) battery capacity for four-hours of backup for light and fan	93,000
		• 1 HP DC solar water pump with USPC to support light and fan load • 150 Ah (75x2) (12 V) battery capacity for four-hours of backup for light and fan	1,60,000

Note: Costs reflect average figures and can vary depending on the location and supply chain.
Source: SIA estimates

b. Primary health centre

For a PHC, typical power requirement includes 10-15 lights and fans, a water pump and a medicine/vaccine freezer. There are many other equipment that PHCs are required to have to provide maternity and childcare-related services, which were not seen to be operational in any of the six PHCs surveyed by SIA.

The existing requirements of PHC add to a load of 3.2 kW with a varying backup requirement of 6-12 hours depending on the local power scenario. To provide improved services in the existing scenario, a solar panel capacity of 5 kW would be required with a battery size of 2,000 Ah to 1,000 Ah. Such a system would cost up to ₹4.3 lakh. As more maternity and childcare equipment are added to the PHC, solar and battery capacities can be adequately expanded in later phases of solarisation.

Table 4.4: Consumption load and solar capacity requirement at PHCs

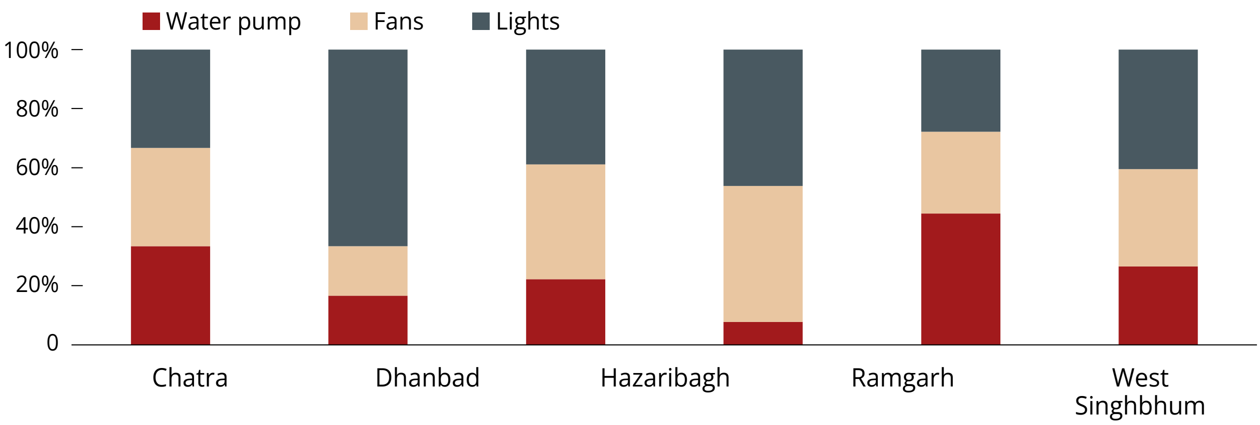
Load details	Optimum system	Cost (₹)
• 15 bulbs of 20 W • 10 fans of 50 W • 1 HP water pumps • 1 freezer of 200-litre capacity	• 5 kW solar grid-connected system with 5 kW (24V) hybrid inverter • 2,000 Ah (12V) battery capacity for 12 hours of backup	4,30,000
	• 5 kW solar grid-connected system with 5 kW (24V) hybrid inverter • 1,000 Ah (12V) battery capacity for six hours of back up	3,55,000

Note: Costs reflect average figures and can vary depending on the location and supply chain.
Source: SIA estimates

4.1.3 Solar for Anganwadi centres

Comprehensive steps towards upgrading Anganwadi centres in Jharkhand are yet to be taken up, but there are many instances of district administrations and CSR funds supporting projects for developing model Anganwadi centres to promote education and eradicate child malnutrition. So far, the interventions related to energy have primarily focused on setting up solar *Jal Minar* around the premises to meet the water requirement. However, in the SIA survey, Anganwadi workers unanimously voice that comprehensive solarisation can have a widespread impact of child welfare. When asked to prioritise solar equipment requirement, 86 per cent of the workers mentioned immediate requirement of lighting, 70 per cent mentioned the cooling (fan) requirement and 57 per cent mentioned water pumping requirement.

Graph 4.5: Priority for solarisation of equipment at Anganwadi centres



Note: Data reflects perception of surveyed Anganwadi centre representatives.
Source: SIA survey

Specification and costs

Given that the typical power requirement of Anganwadi centres is also limited to 2-4 light bulbs, two fans and a small water pump as seen during the survey, the estimated load requirement stands at 1.3 kW.

Option 1: A 2 kW solar panel capacity, supported by a battery of 75 Ah capacity to provide two hours of backup, would be sufficient to meet all the requirements. Given the limited hours of operation of the water pump, there is adequate surplus available to add additional equipment like exhaust fan, smart board, small air cooler etc. Even if the centres are located on rooms owned by panchayat or other local bodies, a small solar installation can be easily put up on the roof area or on nearby community-owned ground, since the area requirement for the installation would be about 200 square feet. The solar generation system including batteries would cost around ₹1.16 lakh.

Option 2: An alternate model for Anganwadi centres would be to install 1 HP DC solar pump with USPC. The pumps can be operated during the early part of the day to fill the tank, while the generated power is used for running light, fan and charging battery during the rest of the day. This would be a more cost-effective solution as a 1 HP solar water pump with USPC would cost about ₹1.26 lakh.

Option 3: Anganwadi centres that already have a *Jal Minar* in the vicinity can benefit from installation of a USPC for supporting lighting and fan requirement. This will be the most cost-effective solution.

Table 4.5: Consumption load and solar capacity requirement at Anganwadi centre

Load details	Category	System size	Cost (₹)
• Two bulbs of 20W • Two fans of 50W • 1 HP water pumps	Without an existing solar *Jal Minar*	• 2 kW solar grid-connected system with 2 kW hybrid inverter • 75 Ah (12 V) battery capacity for two hours of back up for light and fan	1,16,500 (excluding 1 HP electric pump cost)
		• 1 HP DC solar water pump with USPC to support light and fan load • 75 Ah (12 V) battery capacity for two hours of back up for light and fan	1,26,500
	With an existing solar *Jal Minar*	• USPC installation for supporting lights and bulbs. • 200 Ah (12 V) battery capacity for two hours of back up for light and fan	30,000

Note: Costs reflect average figures and can vary depending on the location and supply chain.
Source: SIA estimates

4.2 SOLARISATION OF EDUCATION

The education sector, the primary agent of transformation, remains the weakest in Jharkhand. The last national census conducted in 2011 had revealed the state's overall literacy rate to be 66 per cent, including 77 per cent for men and 55 per cent for women. The state government's efforts over the past decade have resulted in outcome improvements, however, there remains a vast scope for further improvements. According to the NFHS-5, the female literacy rate has improved to 62 per cent, and the male literacy rate has reached 81 per cent. Many studies confirm that access to education is lower in rural and particularly tribal communities.

At present, Jharkhand has a total of 41,190 schools operating in rural areas and 4,129 schools in urban areas, as per the Unified District Information System for Education (UDISE) database. However, critical gaps in learning outcomes remain due to the low enrolment levels, high dropout rates, lack of qualified teachers, and lack of adequate infrastructure. In this, the availability of electricity remains a critical gap area.

4.2.1 Role of electricity access

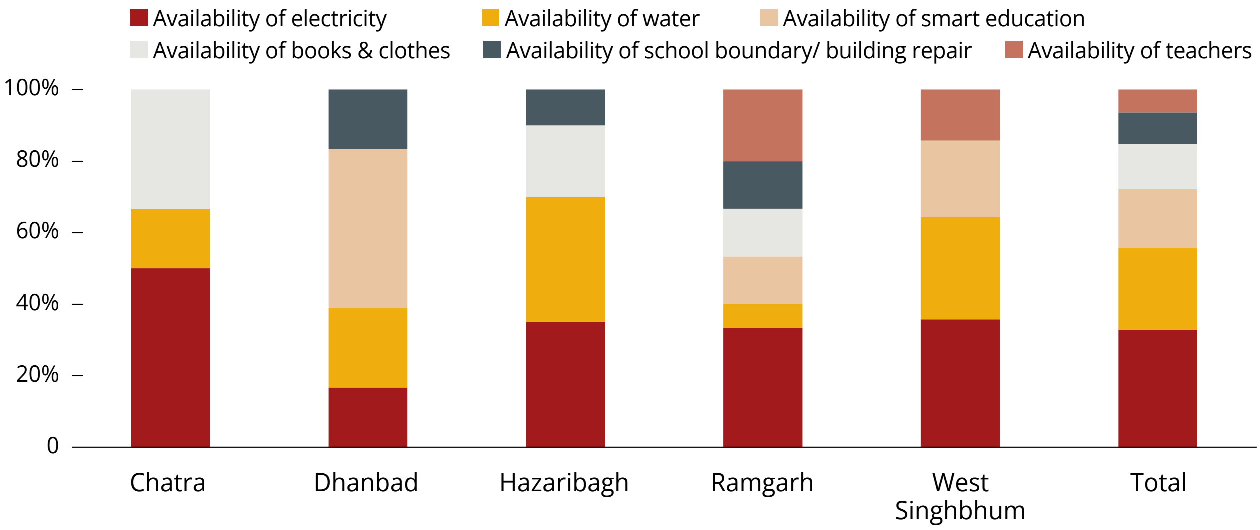
The centrality of electricity in improving quality of education is reflected in Jharkhand government's recent initiative to develop government schools into 'Schools of Excellence'. Under this, a key strategy to improve the quality education delivered to the students entails equipping schools with an uninterrupted electricity supply that provides adequate lighting and cooling facilities, drinking water facility as well as provide smart education facilities. The significance of electricity is also reflected in the surveys conducted by SIA, wherein 72 per cent of the surveyed representatives listed electricity availability among immediate priorities for

Grid-connected Secondary school, Simaria, Chatra

Bablu Das

improving the quality of education. This was followed by the availability of drinking water (quoted by 50 per cent of the representatives) and the availability smart education facilities (quoted by 36 per cent) – both being fundamentally linked to electricity supply.

Graph 4.6: Key areas to improve quality in education delivery in Jharkhand



Note: Data reflects perception of surveyed school representatives, and frequency of mentions
Source: SIA survey

The electrification scenario in terms of the grid connection has improved in Jharkhand, but the quality of supply remains concerning. In the five focus districts, of the 34,402 rural schools tracked in the UDISE database, 95 per cent have grid connection and 91 per cent have functional electric connection. The database reports water to be available in 96 per cent of the schools and water, sanitation, and hygiene (WASH) facilities to be available in 86 per cent of the schools. The gaps were found to be slightly higher under the SIA survey, at 17 per cent for functional electricity and 28 per cent for water availability.

Due to the poor quality of power supply, the schools continue to face many operational challenges. In the SIA survey, a range of issues were reported due to the lack of power supply across both grid-connected and not connected schools, including too hot to studies in summers (mentioned 43 per cent of time), inadequate lighting in classes (30 per cent), the lack of water supply (18 per cent), the lack of digital education/computers/smart classes etc. (10 per cent). The need for cooling is only going to increase in the coming years as climate change leads to increased instances of heat wave across India.

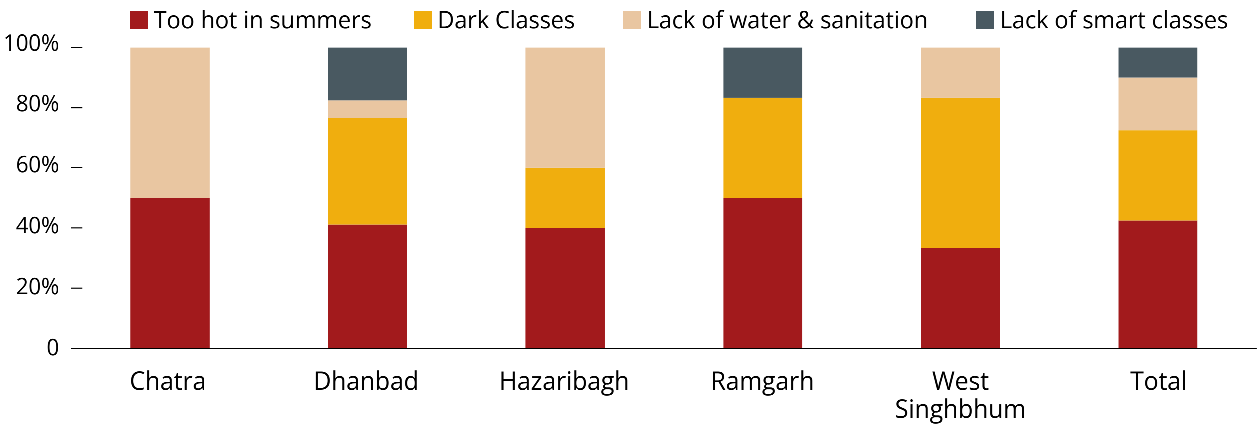
An overwhelming majority of school representatives stated that improving electricity availability in schools can lead to improvements in quality of education. These included all representatives surveyed in Chatra, Dhanbad, Hazaribagh and Ramgarh.

Table 4.6: Electricity and water availability in rural schools in focus districts of Jharkhand

Parameter	Chatra	Dhanbad	Hazaribagh	West Singhbhum	Ramgarh	Total
Number of schools	1,776	1,846	2,173	2,197	768	34,402
Availability of grid connection	1,594	1,800	2,069	1,971	750	32,671
Availability of functional electric connection	1,523	1,774	2,047	1,941	744	31,470
Availability of drinking water	1,623	1,819	2,010	2,013	744	32,958
Availability of WASH facility	1,617	1,741	1,921	1,688	729	29,669

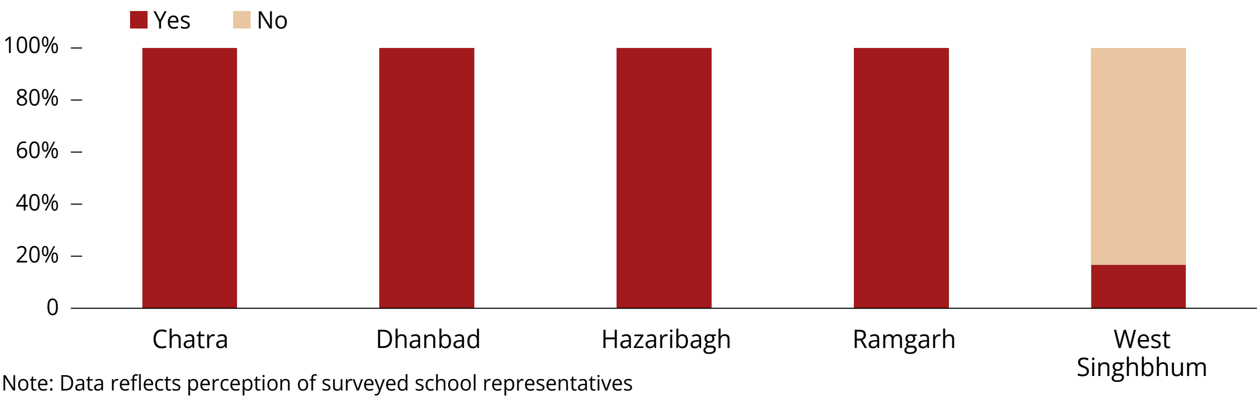
Source: UDISE+ 2020-21

Graph 4.7: Key issues being faced by schools due to the lack of power supply



Note: Data reflects perception of surveyed school representatives, and frequency of mentions
Source: SIA survey

Graph 4.8: Expectation of improvements in quality of education with improved power availability



Note: Data reflects perception of surveyed school representatives
Source: SIA survey

4.2.2 Solar for schools

Solar is already being explored as a viable solution for resolving the power requirement of the schools. Solar is ideally suited as the requirement of power is day-based (from 8 AM to 3 PM), and there is adequate rooftop space available with schools to support installations. As per the UDISE database, solar panels have already been installed at 4,378 schools across the five focus districts.

However, the current approach to solarisation appears to be lacking. During the survey, SIA reviewed solar installations at five randomly selected schools, including two in Chatra and three in Dhanbad. At all five locations, solar was meeting only the water supply requirement through a 1 HP DC pump. At the time of the visit, two of these pumps were not operational due to the balance of system issues. While the surveyed school representatives unanimously agreed on the role of solar in improving the water supply scenario, there was a strong demand to bring additional equipment under solarisation.

Specification and costs

For a small school servicing about 100 students, the power requirement adds up to about 1.8 kW which can be fully met by a rooftop system of 2 kW and a battery support of 200 Ah for two hours of back-up. Such a system would also support additional power requirement of up to five computers.

Similarly, for a large school with up to 400 students, the power requirement adds up to of 3.5 kW. A solar capacity of 5 kW supported by 800 Ah of batteries for two hours of back up would be adequate to meeting the basic requirements as well as support 10 computers. The systems for a small school would cost around ₹1,45,000, and for a large school it would cost about ₹3.25 lakh.

Table 4.7: Consumption load and solar capacity requirement at schools

Type	Load details	System size	Cost (₹)
Small school	• Five bulbs of 20 W each • Five fans of 50 W each • 1 HP AC submersible solar pump • Five computers of 50 W each	• 2 kW of solar panel capacity with 2 kW hybrid inverter • 400 Ah (12 V) battery capacity for 2 hours of back up for light, fan and computers	1,45,000
Large school	• 15 bulbs of 20 W each • 15 fans of 50 W each • 1 HP AC submersible solar pump • 10 computers of 50 W each	• 5 kW of solar panel capacity with 2 kW hybrid inverter • 800 Ah (12 V) battery capacity for 2 hours of back up for light, fan and computers	3,25,000

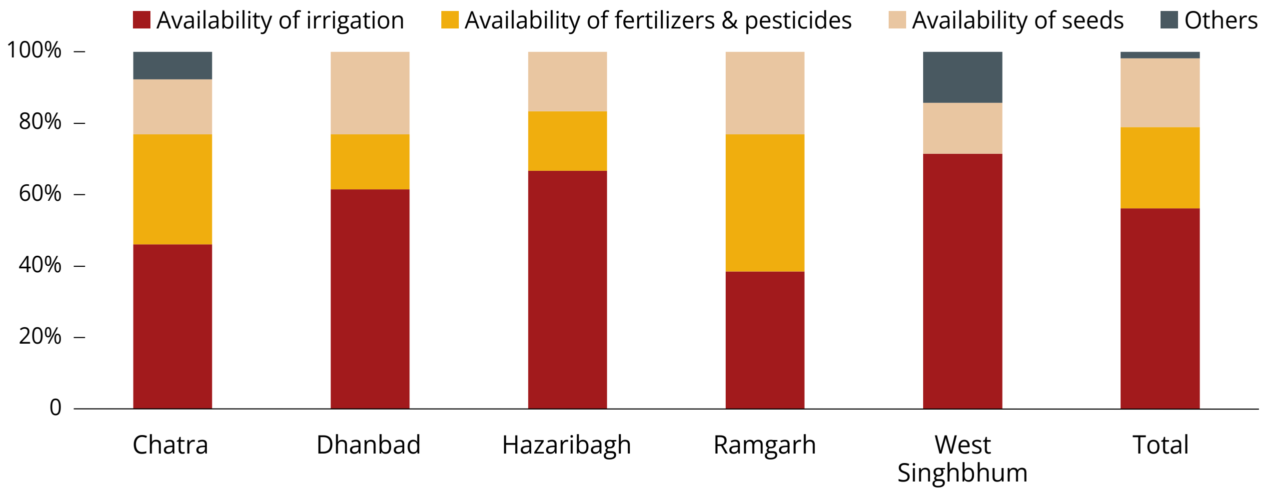
Note: Costs reflect average figures and can vary depending on location and supply chain.
Source: SIA estimates

Solar irrigation system, Baghmara, Dhanbad Ritwik Ray Chaudhuri, SIA

4.3 SOLARISATION FOR PRIMARY SECTOR

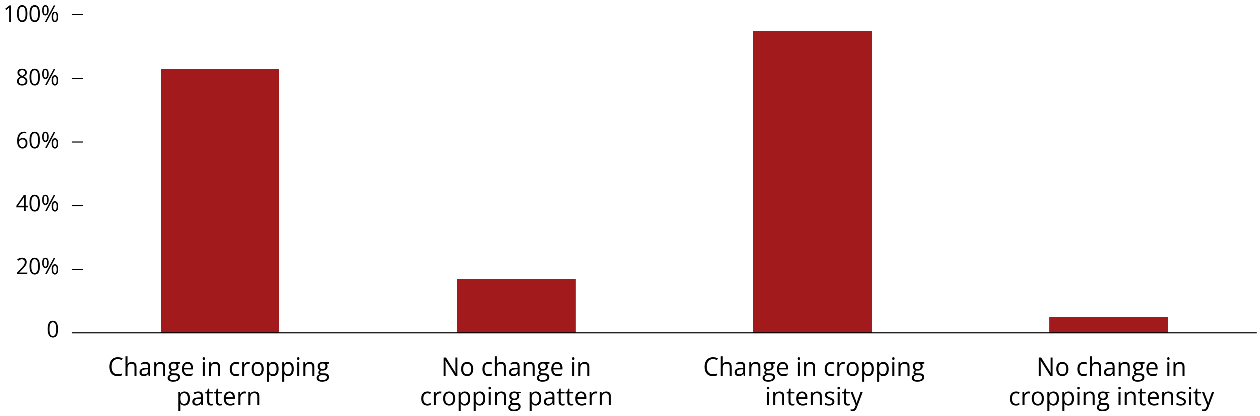
While there are gaps across the agriculture value chain in Jharkhand from input availability to market linkages, irrigation is viewed as a primary requirement to be prioritised. During the indicative needs assessment survey, 32 out of the 34 randomly-selected farmers listed availability of irrigation as the biggest issue to address for improving agriculture output in the state. This was followed by 13 seeking improved availability of fertilisers and pesticides and 11 seeking improved availability of seeds. In their own experience, since all the surveyed farmers had access to either diesel or electric pumps, a clear majority indicated that there was an improvement in cropping intensity and that there was a diversification of crops following stable access to pumping.

Graph 4.9: Key issues to address in Jharkhand to increase agriculture output



Note: Data reflects perception of surveyed famers, and frequency of mentions
Source: SIA Survey

Graph 4.10: Impact of access to irrigation on cropping pattern and intensity



Source: SIA Survey

AGRICULTURE IN JHARKHAND AND CLIMATE CHANGE

Expanding irrigation access should be a priority concern for Jharkhand, due to the rising impact of climate change on agriculture, as well as the high climate vulnerability of the local population towards climate change.

Jharkhand is highly climate sensitive. According to a recent study by the Centre for Study of Science, Technology and Policy (CSTEP), Jharkhand recorded a warming of 0.1°C to 0.48°C in the summer maximum temperature, and 0.33°C to 0.54°C in the winter minimum temperature between 1990 and 2019. In recent decades, the frequency of droughts, heatwaves, cyclones, flash floods, and forest fires in the state has increased, and will continue to increase in the absence of strong mitigation measures. The report projects that summer maximum and winter minimum temperatures in Jharkhand will warm by 1°C to 2°C by 2050, while the frequency and intensity of rain is likely to increase in all the districts.[22]

Climate extremes have had a major impact on the agriculture outcomes. Studies show that climate extremes have led to a delay in transplanting/vegetative phase and reduced crop production in the state.[23,24] The Jharkhand State Action Plan for Climate Change and Human Health highlights this concern stating that climate change will reduce the agriculture productivity in the state. This will further reduce the food-grain availability and diminish nourishment levels, which are already among lowest in the country.

Already, Jharkhand is assessed to be the most climate vulnerable state in India, by a study supported by the Department of Science and Technology, Government of India.[25] The key drivers for this being high proportion of population below poverty line, high prevalence of rainfed agriculture, high incidence of vector-borne diseases, lack of forest area per 1,000 rural population, high yield-variability of food grains, low road and rail density, and low number of health care workers.

Jharkhand needs long-term persistent efforts on both the adaptation and mitigation fronts to combat climate change, and access to assured irrigation through solar water pumps caters to both the requirements.

4.3.1 Solar for farm activities

In five focus districts, the status of irrigation is quite sub-optimal. In all districts, the net irrigated area is less than 20 per cent of the total agriculture land. In West Singhbhum, it is negligible. In all districts, there are vast stretches of fallow and uncultivated land, that can be brough under productive use through access to irrigation.

Table 4.8: Details of irrigated and unirrigated land across focus districts

District	Area (hectare)					Number of land holdings
	Net irrigated	Net unirrigated	Current fallow land	Other uncultivated land	Total	
Chatra	22,681	30,882	47,781	13,087	1,14,431	1,44,080
Dhanbad	3,097	12,583	15,890	1,527	33,097	50,651
Hazaribagh	22,724	40,772	44,823	6,336	1,14,655	1,51,232
Ramgarh	4,645	18,257	25,184	3,961	52,047	33,607
West Singhbhum	326	1,06,020	1,27,637	18,379	2,52,362	1,68,610

Source: All India Report on Input Survey 2016-17

Solar can play a vital role in addressing the irrigation gap in the state in a sustainable, climate-friendly manner. Farmers cannot afford irrigation using diesel pumps mainly because of its higher running and maintenance costs, and the use of electric pumps is restricted because of erratic electricity supply and limited access to the agriculture feeder. The state government has been promoting the use of solar powered irrigation pumps through the Jharkhand Opportunities for Harnessing Rural Growth (JOHAR) scheme which was started in 2017 to reduce the dependency of farmers on diesel. The central government is also promoting solar pumps through Pradhan Mantri Kisan Urja Suraksha evam Utthaan Mahabhiyan Yojana (PM KUSUM).

At present, 11,387 solar pumps have been installed in the state through central and state government efforts. Under PM KUSUM, the target is to add 11,000 off-grid solar pumps, of which 6,717 pumps have been installed so far.[26] The scheme is also looking to solarise 10,500 existing electric pumps and add 50 MW of capacity through small solar plants; however, no progress has been made on these fronts yet. Overall, the solar pump installation in Jharkhand is highly inadequate.

Table 4.9: Installed solar water pumps in Jharkhand

Year	Number of solar water pumps
March 2017	3,146
March 2018	3,857
March 2019	4,408
March 2020*	4,670
March 2021	5,051
March 2022	11,387

Source: MNRE; *as of December

Table 4.10: Solar pump installation under PM KUSUM in Jharkhand

	Sanctioned	Installed
Component A (MW)	50	0
Component B (number)	16,717	6,717
Component C (number)	10,500	0

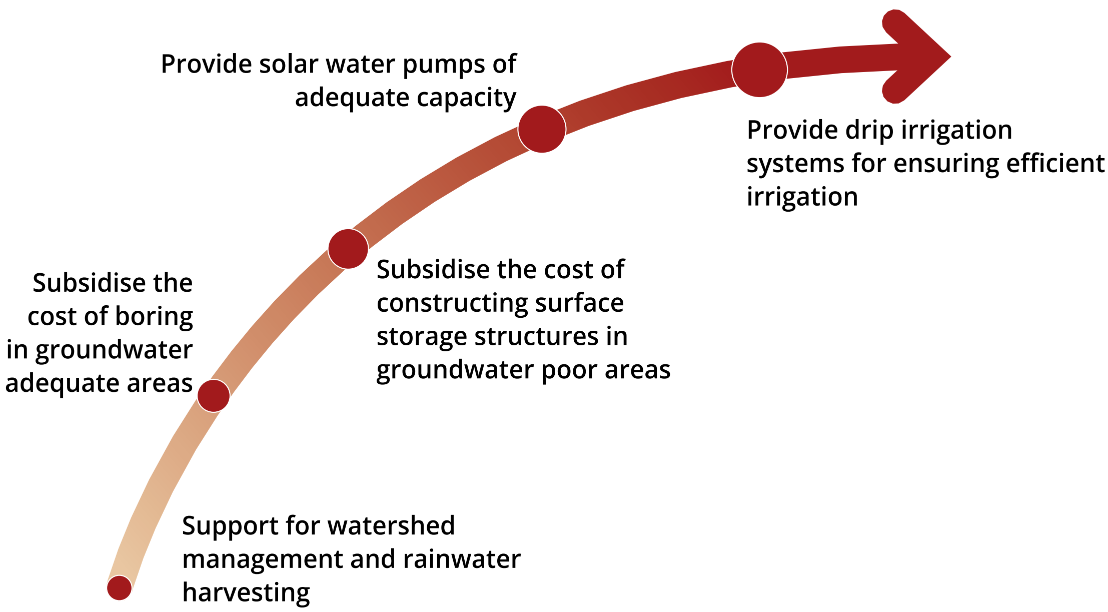
Source: MNRE (as of February 2022)

Solar pump deployment has largely had a positive impact on farming outcomes in Jharkhand. While gaps in the provision of maintenance and repair services have been challenging for farmers, there is widespread appreciation among solar pump users towards increased profitability and the ease of operations (*See Box: Experience of farmers with solar pumps in Jharkhand*).

In view of its positive impact and urgent requirement, there is a need to expand the scope of the existing irrigation solarisation programmes. Against the existing and planned solar pumps in the state, there are notably 38,14,832 cultivators and 44,36,052 agricultural labourers in Jharkhand working on 28,02,946 operational land holdings spread across 30,90,734 hectares of land area. There is clearly a requirement of a multi-fold scale up for universal irrigation to be made possible in Jharkhand.

In addition to scaling up solar pumps to expand irrigation, there is a requirement for comprehensive strengthening of the irrigation ecosystem – addressing the source of water as well as mode of irrigation, given the overall ground water scarcity in the state. A comprehensive solution for solar irrigation, should therefore also include construction of surface water storage facility where groundwater availability is poor, and boring where ground water aquifer capacity is assessed to be adequate. In Odisha, the state solar pump scheme found success with small and marginal farmers as the cost for creating borings for ground water access was also included in the solar pump scheme. In Chhattisgarh, solar pump scheme was implemented in coordination with boring support scheme to facilitate this.[27] Lastly, given the water scarcity challenge, the solar pump scheme should also be clubbed with micro irrigation facilities such as drip irrigation. Such a bundling of solar pumps and drip irrigation was seen to be successful in Rajasthan under the state solar pump scheme.

Figure 4.2: Strengthening the irrigation ecosystem in Jharkhand



Source: SIA Assessment

EXPERIENCE OF FARMERS WITH SOLAR PUMPS IN JHARKHAND

The deployment of solar pumps has largely had a positive impact on the profitability of farmers. During the SIA survey, 12 solar water pump users were interviewed, including five in Dhanbad, two in Ramgarh, and five in West Singhbhum. Following are some observations based on the experiences of farmers:

- The surveyed solar pump users included eight small and marginal farmers, and four medium and semi-medium farmers, who were motivated to adopt the solar pump technique due to irregular grid supply, the non-availability of kerosene, disputes in shared community water resources (from local water bodies), and the demonstrated effectiveness of solar installations in the neighbourhood. In most cases, the farmers had made a 10 per cent contribution towards the procurement of solar pumps under government schemes.
- The surveyed pumps included five pumps of 1 HP, five pumps of 2 HP, and one pump each of 3 HP and 5 HP. Seven of these pumps were submersible pumps and five were surface/shallow water pumps. The selection of pump capacity was driven more by the capacity available under the scheme and the amount contributed by the farmers than the land area and irrigation need.
- They were mostly new solar pumps, with seven pumps installed during 2020-2022, three pumps between 2018 and 2019, and one pump installed in 2015.
- The pump utilisation averaged at about 170 days annually, with the average for Kharif season being 50 and for Rabi season being 75. Some farmers reported higher pump utilisation despite small land holding as they were sharing operations with friends and family.
- The farmers found solar pumps to be convenient to use and well-functioning. However, there was some dissatisfaction pertaining to the after-sales services issues. Six of the surveyed farmers reported to have never faced any issues, five more had rarely faced any issues, while one farmer, with the oldest installed pumps, had regularly been facing breakdowns.
- Overall, all farmers reported being satisfied with the operations of the pumps. However, only half of the interviewed farmers reported being satisfied with the pump maintenance. The reason for dissatisfaction was primarily due to the lack of after-sales support. Farmers reported to have been given basic training on operations, but limited training on maintenance and troubleshooting.
- Farmers demanded that more services should be brought under solarisation including drip irrigation, lights, seed sowers, harvesters, seed dryers, cold storage, as well as allied activities like poultry, fishery and dairy.

Specification and costs

Solar water pumps are available under many specifications, with varying combinations of AC and DC pumps, and submersible and surface pumps. The most commonly available capacities are 1 HP, 2 HP, 3 HP and 5 HP pumps, largely due to the design of the past subsidy schemes. The ongoing PM KUSUM scheme provides for subsidies for pumps ranging from 1 HP to 7.5 HP. However, there is a vast scope for promoting micro-pumps of less than 1 HP as well, which currently remains in limited use.

In the case of Jharkhand, there is a much higher scope for promoting pumps of smaller sizes as 70 per cent of agricultural land holdings in the state remain marginal. A sub-1 HP is adequate to meet the requirement of marginal farmers as it can irrigate up to one acre of land area, giving a moderate water flow and an output of about 30,000 litres per day.[28] It is highly portable, and can also be utilised for supporting allied activities of the farmers such as fisheries, aquaculture, dairy and poultry. The affordability of such pumps is also better due to the moderate upfront payment, as the pumps cost around ₹40,000 to ₹50,000.

For small and semi-medium farmers, comprising 15 per cent and 10 per cent of the total land holdings, 1-5 HP pumps would be adequate as they can irrigate around five acres of land with a water output of 1,50,000 liters per day. In the case of the remaining 5 per cent of the farmers in Jharkhand, that belong to the medium and large category, either higher capacity or multiple 5 HP pumps would be required.

Further, the solar pumps should be accompanied by a USPC to optimally utilise the power generation capacity of the panels. This is because irrigation requirement is only for a limited number of hours and limited number of days. The power generated by the solar panels can be utilised for other farming tasks through installation of a USPC. This not only increases the productivity of panels but also the productivity of farmers by supporting electrification of other farming activities. This is particularly important for Jharkhand as the extent of mechanisation remains low. During the survey interactions, farmers raised many electricity-dependent requirements, including that of sowing, harvesting, processing etc.

The cost of solar pumps has decreased considerably in recent years. At present, the cost of solar pumps without USPC ranges from about ₹1 lakh per HP to ₹40,000 per HP as the pump size increases, while with the USPC, the cost increases by ₹6,000-₹11,000 per HP.

Table 4.11: Categorisation of farmers in Jharkhand based on operational land holdings

Farmer category	Number	Area (Hectare)	Average size (hectare)
Marginal	19,61,615	7,54,009.2	0.38
Small	4,18,684	5,69,485.3	1.36
Semi-medium	2,77,306	7,55,488.3	2.72
Medium	1,25,514	7,07,844.4	5.64
Large	19,827	3,03,906.9	15.33
Total	28,02,946	30,90,734	1.1

Source: All India Report on Input Survey 2016-17

Table 4.12: MNRE benchmark costs for solar water pumps of various configurations

Pump capacity	Type	Costs (₹ per pump)
1 HP	Without USPC	96,877
2 HP	Without USPC	1,23,691
3 HP	Without USPC	1,66,299
	With USPC	1,99,540
5 HP	Without USPC	2,34,618
	With USPC	2,81,542
7.5 HP	Without USPC	3,26,079
	With USPC	3,74,931
10 HP	Without USPC	4,07,897
	With USPC	4,69,054

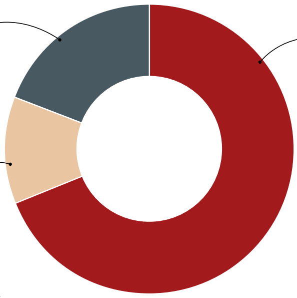
Source: MNRE

4.3.2 Solar for agriculture-based microenterprises

Microenterprises play a crucial role in poverty alleviation in villages by creating livelihood opportunities for landless, women and landholding people. These enterprises not only contribute to enhancing the household income of the individual owner but also supply resilient and flexible services to the community.[29] In the surveyed panchayats, it was reported that nearly 27 per cent of the households were engaged in some form of micro-enterprise ranging from agriculture output processing activities and allied sector activities.

There is a vast scope for solarisation of microenterprises due to the erratic grid-based power supply and high dependence on diesel motors. The SIA survey of 35 entrepreneurs found that 90 per cent of the motor-based microenterprises continued to depend on diesel despite grid connection. The prospect for scaling up operations of these entreprenuers was found to be largely low due to the high and rising input cost of diesel as well as the challenges with fuel availability. The promotion of solar-backed applications or solarisation of the existing business can easily be taken up to address the electricity-related challenges of these micro-entrepreneurs.

Graph 4.11: Prospect of scaling-up the operations of agri-based microenterprises



Note: Based on responses of 16 entrepreneurs
Source: SIA survey

Specifications and costs

The existing businesses have varied requirements depending on the type of business and scale of operations. The standardisation of specification and cost is, therefore, difficult. However, a promotional programme can be launched with the following standard specification:

1. For micro businesses without grinding and processing: A 2 kW solar panel backed by two hours of battery back-up can be provided to support a small business at a total investment cost of about ₹1.8 lakh.
2. For micro businesses with griding and processing: These businesses require higher capacity motors, and hence should be supported by 5 kW and 10 kW systems at a cost of ₹4.5 lakh and ₹9 lakh.
3. Alternatively, entrepreneurs can also be supported with solar applications for productive end use, such as solar milking machines, poultry incubators, dryers, grinders, milling and processing machines, aerators, heaters, chillers, freezers etc. which provide higher efficiency.

Solar cold storage, Baghmara, Dhanbad Ritwik Ray Chaudhuri, SIA

4.4 COMMUNITY LEVEL SOLARISATION

Centralised electrification plan based on solar can be conceptualised for a few villages with a large number of load centres requiring solar intervention. Such a mini-grid solution can provide electricity for all community requirements, including priority areas of health centres, Anganwadi centres, schools, and streetlights etc., accommodate other common load such as panchayat office, police *chowki*, community halls, etc. as well as the existing and upcoming micro enterprises, depending on the requirement. This will also help support the state government target facilitating setting up of 1,000 solar villages aggregating a capacity of 110 MW under the Jharkhand Solar Policy 2022.

A number of micro- and mini-grids have been deployed in rural Jharkhand backed by varied set of renewable energy sources including solar, biomass, pico-hydro etc. to provide energy access to villages and hamlets with no grid connection. While some of these have perished due to O&M concerns, some continue to survive despite grid reaching the villages by providing parallel, back-up connection to the end-users. (*Refer section 6.1 for more on mini-grids*)

In the present scenario, mini-grid deployments can be considered for villages with no-grid connection or with very low duration of power supply. To minimise the requirement of network development in the case of grid-connected villages and having parallel power lines, it would be ideal to identify compact villages where health, education and nutrition centres are located in the close proximity. There should also be availability of community land adequate to set up a 20-kW system. A 20 kW mini-grid system, which provides metered electricity to 5-10 high load connections, is likely to cost ₹20-25 lakh.

4.5 CONCLUSION

Overall, the scope of solarisation in the context of the focus sectors is high, given the existing gaps in functional electrification and reliable power supply, the central role of electricity in enhancing service outcomes and profitability, and the affordable prices of solar technology. The existing requirements of Anganwadi centres, health sub-centres, PHCs and schools can be supported with 2 kW to 5 kW systems with 2-6 hours of power back-up. Irrigation access can be expanded through the deployment of small to medium capacity solar water pumps, while the requirement of micro-enterprises can be addressed through solutions varying from 2 kW to 10 kW depending on the scale of operations. There is a strong case for priority public spending on solarisation through the funds available under District Mineral Foundation (DMF), as it can help enhance the quality of services being delivered under a number of priority and other sector areas of spending.

Arpo Mukherjee, SIA

5. DMF FOR SUPPORTING DRE

District Mineral Foundation (DMF) was instituted under the provisions of the Mines and Minerals (Development and Regulation) Amendment Act, 2015. Developed as a non-profit trust in every mining district of India (irrespective of the kind of mineral mined and production capacity), the objective of the DMF is to work as a vehicle for poverty alleviation, and socio-economic upliftment of the mining-affected areas, and the local communities. The DMF fund comes through a mandatory contribution by mining companies operating in the districts. For mining leases granted before 2015, the payment to DMF is determined as a 30 per cent equivalent to the royalty amount, and for leases granted after that, it is 10 per cent of the royalty.

As of May 2022, ₹63,845.52 crore had been collected across 622 mining districts in India, according to the Ministry of Mines.[30] Jharkhand has the third highest DMF accumulation at ₹8,301.37 crore, following Odisha (₹18,730.27 crore) and Chhattisgarh (₹9,223.99 crore).

In Jharkhand, the DMF rules were introduced in March 2016. These rules, underlined by the Pradhan Mantri Khanij Kshetra Kalyan Yojana (PMKKKY) guidelines, identify the Department of Industries, Mines and Geology as the nodal agency for DMF in the state. They also identify the procedure to be followed for the selection of projects for DMF spending and the areas of spending priority.

Procedure for project selection: As per the DMF rules, project selection follows a bottom-up approach wherein the *Gram Sabhas*, in consultation with the mukhiya/up-mukhiya, identify the works to be carried out. Following this, the Management Committee drafts an annual plan and its feasibility study taking inputs from various *Gram Sabhas* and the concerned departments. The projects are then presented for approval from the Governing Council.

The Management Committee typically comprises Deputy Commissioner, Deputy Development Commissioner, Senior Superintendent of Police, Divisional Forest Officer, District Mining Officer, Civil Surgeon, and District Panchayati Raj Officer. Further, these officers are also part of the Governing Council, in addition to some other representative members, such as Chairman Zila Parishad, and from major industries in the district.

Areas of priority for spending priority: Guided by the PMKKKY, the areas identified for DMF spending are split into two broad categories. There are eight high-priority areas and four other priority areas on which fund spending is to be split in a 60:40 ratio. The high-priority areas focus on the development of social infrastructures such as drinking water, health, education, sanitation, as well as pollution control, social welfare, and skill development. Other priority areas call for investments in physical infrastructure, energy, and irrigation etc.

Table 5.1: Areas identified as 'high priority' for DMF spending in Jharkhand

Drinking water supply	• Centralised purification system • Water treatment plants • Permanent/temporary water distribution networks including standalone facilities for drinking water, and laying of piped water supply system
Environment preservation and pollution control	• Effluent treatment plants • Prevention of pollution of streams, lakes, ponds, ground water, other water sources • Measure for controlling air and dust pollution caused by mining operations and dumps • Mine drainage system and mine pollution prevention technologies • Measures for working on abandoned mines • Other air, water and surface pollution control mechanisms required for environment-friendly and sustainable mine development
Health care	• Setting up primary/secondary healthcare facilities • Provision of necessary staffing, equipment, and supplies for effective operations • Group insurance scheme for health

Education	• Construction of school buildings and additional infrastructure (classrooms, laboratories, libraries, art and craft room, toilet blocks, drinking water provisions, residential hostels, sports infrastructure etc.) • Engagement of teachers/other supporting staff • E-learning setup • Arrangement of transport facilities • Nutrition related programs
Welfare of Women and Children	• Programmes to address maternal and child health issues, malnutrition, infectious diseases, etc.
Welfare of aged and disabled people	• Special programme for welfare of aged and disabled people
Skill development for livelihood support	• Trainings • Setting up of skill development centre • Self-employment schemes • Support to self help groups • Building linkage for self-employment
Sanitation	• Collection, transportation & disposal of waste • Cleaning of public places • Provision of proper drainage and disposal of fecal sludge • Sewage treatment plant • Provision of toilets

Table 5.2: Areas identified as 'other priority' for DMF spending in Jharkhand

Physical infrastructure	• Building road, bridges, railways, and waterways projects
Irrigation	• Development of alternate sources of irrigation • Adoption of suitable and advanced irrigation techniques
Energy and Watershed Development	• Development of alternate source of energy (including micro-hydel) and rainwater harvesting system • Development of orchards, integrated farming and economic forestry and restoration of catchments
Others	• Any other measure for environmental improvements

5.1 DMF UTILISATION TRENDS

Of the ₹8,300 crore DMF funds accumulated by Jharkhand so far, 6,602 projects aggregating ₹5,704 crore have been sanctioned (till February 2022). Of the sanctioned projects, 3,315 projects have been completed aggregating an investment amount of ₹4,198.23 crore. So far, 92 per cent of the spending has been focused on high priority areas, while 8 per cent have been on other priority areas. Within the high priority investments, 85 per cent have been cornered by drinking water supply projects, 11 per cent by sanitation projects, two per cent by health and one per cent by education.

DMF spending in the five focus districts also reflect a similar tends. Drinking water is the key focus area across all the five districts – accounting for 92 per cent of the sanctioned amount in Hazaribagh, 88 per cent in Dhanbad, 81 per cent in West Singhbhum, 78 per cent in Ramgarh, 77 per cent in Chatra. Sanitation is the second most important area of spending in each district (5 to 12 per cent share), followed by health, education, and physical infrastructure development.

Table 5.3: DMF utilisation of Jharkhand as of February 2022

Details	Number of projects	Amount spent/committed (₹ crore)
Projects sanctioned	6,602	5,704
Projects yet to start	1,201	-
Completed projects	3,315	4,198
Ongoing projects	1,864	-
Scrapped/cancelled projects	222	-

Source: Ministry of Mines, Government of India

Table 5.4: Sector-wise DMF spending in Jharkhand as of February 2022

Area	Spending area	Number of projects	Amount Spent (₹ Cr)
High priority areas	Drinking water supply	3,499	2,875.01
	Environment Preservation and pollution control measures	6	1.46
	Health	138	60.47
	Education	343	43.18
	Welfare of Women and Children	1,147	12.99
	Welfare of aged and disabled people	1	0
	Skill development	34	6.25
	Sanitation	18	383.7
	Total	**5,186**	**3,383.14**
Other Priority work	Physical infrastructure	503	201.99
	Irrigation	173	63.66
	Energy and watershed development	3	1.28
	Any other measures for enhancing environmental quality	9	1.08
	Others	72	34.48
	Total	**760**	**302.49**
Total		**5,946**	**3,685.63**

Source: Ministry of Mines, Government of India

Table 5.5: Segment-wise DMF spending in five focus districts

Districts	Spending area	No. of Schemes	Sanctioned amount (₹ crore)	Spent amount (₹ crore)
Chatra	Drinking Water	19	328.03	193.47
	Health care	6	3.34	3.13
	Education	10	13.21	3.70
	Women and Child Welfare and Development	9	10.01	1.63
	ODF/Sanitation	1	50.48	49.61
	Physical infrastructure	6	20.73	17.08
	Total	**51**	**425.80**	**268.62**

Districts	Spending area	No. of Schemes	Sanctioned amount (₹ crore)	Spent amount (₹ crore)
Dhanbad	Drinking Water	72	1,527.93	1,027.29
	Environment Preservation and Pollution Control Measures	4	3.22	3.22
	Health care	58	19.10	8.54
	Skill development	6	0.93	0.79
	ODF/Sanitation	1	130.72	111.42
	Physical infrastructure	56	57.99	36.20
	Energy and watershed Development	2	1.73	0.37
	Total	**199**	**1,741.62**	**11,87.83**
Hazaribagh	Drinking Water	9	126.14	84.72
	Health care	1	0.47	0.47
	Women and Child Welfare and Development	1	0.10	-
	ODF/Sanitation	1	10.85	10.85
	Others	3	0.12	0.12
	Total	**15**	**137.67**	**96.16**
Ramgarh	Drinking Water	545	710.65	650.76
	Health care	16	9.19	6.42
	Education	3	4.60	4.50
	Women and Child Welfare and Development	1	0.31	0.31
	Skill development	1	0.45	0.45
	ODF/Sanitation	1	62.61	57.37
	Physical infrastructure	117	111.57	88.69
	Agriculture	10	11.91	11.07
	Others	2	0.05	0.04
	Total	**697**	**911.34**	**819.62**
West Singhbhum	Drinking Water	335	867.12	622.08
	Environment Preservation and Pollution Control Measures	5	2.31	1.15
	Health care	33	6.28	5.37
	Education	109	26.94	18.59
	Women and Child Welfare and Development	1	4.36	4.36
	Skill development	2	0.96	0.81
	ODF/Sanitation	1	57.90	43.29
	Physical infrastructure	218	103.86	80.94
	Irrigation	3	1.17	0.59
	Energy and watershed Development	3	1.32	1.28
	Others	6	1.91	1.48
	Total	**716**	**1,074.12**	**779.93**

Source: Department of Industries, Mines and Geology, Jharkhand

5.2 DRE INVESTMENTS THROUGH DMF

Energy is already listed among other priority areas in the DMF, however, the spending on energy through DMF has so far been minimal in Jharkhand. Only three energy and watershed projects aggregating ₹1.28 crore have been implemented through DMF in the state. The mining-affected districts in the state need to make focused investments in distributed renewable energy (DRE) due to the massive gap in grid-based energy supply in the provision of social services and in the creation of economic opportunities.

Mobilising DRE investments through DMF can help in view of the following:

1. Optimise investments in priority and other spending areas: Reliable electricity supply forms a vital element of ensuring sustainability of investments made under the key priority areas of DMF pertaining to social infrastructure development, including water supply, sanitation, health and education, as well as under the other priority area of irrigation. DMF is already investing significant amounts of money into social infrastructure development. However, as revealed by SIA's indicative needs assessment survey, lack of power is a major hindrance in ensuring improved services and thus should be prioritised. DMF funds can help address this gap and optimise investments already being rolled out.

2. Supplement state efforts for improving energy access: Under the guidelines provided by the PMKKKY, DMF should be making efforts to achieve convergence with central and state development plans so that activities taken up by the DMF supplement the development and welfare activities, and are treated as extra-budgetary resources of the plans of the state. The Jharkhand Solar Policy 2022 seeks to address the energy access issue in villages by targeting 280 MW of off-grid solar installations, including setting up 1,000 solar villages, deployment of solar home lighting systems, solar livelihood applications and solar water pumps. Already, the JAREDA has initiated tenders to provide solar power to state PHCs and CHCs.

DMF can play a crucial role in fast-tracking these objectives in the respective districts, by acting as catalysis for innovation as well as by providing the much-needed extra budgetary support. It is well placed to provide scale-up support to DRE interventions within each district, not just due to the capability to provide upfront funding support; due to the local presence, capacity and understanding that can help ensure adequacy and sustainability of investments.

3. Adopt a cluster-based approach: DMF is mandated to spend on development areas that improve well-being of the population directly or indirectly affected by mining-related operations in the district. All mining districts have, therefore, prepared a list of these areas by identifying either blocks or specific villages as per the provisions of the State DMF Trust Rules, 2016. In the five focus districts, due to the large-scale mining presence, most of the geographic area comes under directly or indirectly affected regions. The DRE-based interventions under DMF for building energy access in rural areas can thus adopt a cluster approach of covering all or a large number of locations and target-users within the district. This would help build economies of scale, leading to cost and service quality benefits.

4. Ensuring implementation efficiency, investment sustainability and job creation: With a better understanding of the ground-level scenario, DMF is suitably placed to identify the most critical demand areas to address to maximise the benefits to the mining-affected population. It can ensure implementation efficiency through district-level demand aggregation, which would help build scale at a local level, ideal for driving down costs and ensuring effective delivery of after-sales services. DMF can also take effective steps to build a supporting ecosystem for DRE investments through efforts towards solar skill building among the local population for installation, repair, maintenance and monitoring works. This would not only help ensure sustainability of investments but also create hundreds of jobs locally.

5.2.1. Focus sectors for DMF investment

An objective assessment of solarisation priority across focus sectors can be done based on five broad criteria of current need, DMF piroity area, convergence with existing DMF spending, convergence with state's solarisation priorities and societal benefits.

- **Current need:** The current need for solarisation is high across all segments under consideration, partly due to the gaps in electrification, functional electrification, poor quality of power supply and high dependence on diesel. However, relative to other sectors, the present need is assessed to be low in the case of piped water supply since most pump stations have dedicated feeder lines and are able to provide 0.5-3 hours of water supply. The Public Health Engineering Department (PHED), responsible for the construction and operations of piped water supply, can eventually consider solarisation of pump houses to reduce the cost of operations. Also, in the case of streetlights, the relative need is assessed to be low because the reach of streetlights has increased (as per the indicative survey). The need may be assessed to be higher in specific districts and blocks.
- **DMF priority areas:** Solarisation investments in Anganwadi centres, health centres, schools and drinking water supply are targeted at addressing the energy requirements of social infrastructure sectors of health, education and drinking water included in the high-priority areas for DMF spending. In addition, irrigation and energy are generally included in the other priority areas for DMF spending.
- **Convergence with existing DMF expenses:** Overall, for most districts of Jharkhand, including the focus districts, a disproportionately high level of DMF spending has been put in for expanding the reach of piped water supply. Other areas of focus with high spending include health, education, and irrigation.
- **Convergence with existing solarisation priorities:** Many state and central level support schemes are currently ongoing to support solarisation of various segments. These include solarisation of health centres, irrigation and livelihoods. DMF spending can supplement these spendings through local level action.
- **Societal benefits:** Social infrastructure interventions, by design, lead to societal benefits impacting a large number of individuals. Solarisation of Anganwadi centres, health centres, schools and streetlights would improve the quality of services being delivered to a vast number of the rural population. Even in the case of irrigation and micro-enterprises, the societal benefit is assessed to be high due to the high employment dependence of these segments, and their role in building resilience. In the case of piped water supply, the present assessed societal benefit is low because these would typically translate as economic benefits for the PHED department.

Based on these assessment criteria, health centres, Anganwadi centres, schools, irrigation and micro-enterprises emerge as clear priority areas for solarisation through DMF.

Table 5.6: Priority matrix for solarisation investments under DMF

	Anganwadi centres	Health centres	Schools	Irrigation	Micro-enterprises	Community lighting	Piped water supply
Current need	High	High	High	High	High	Low	Low
DMF priority area	High	High	High	Low	Low	Low	High
Convergence with existing expenses	High	High	High	High	Low	Low	High
Convergence with existing solarisation priorities	Low	High	Low	High	High	Low	Low
Societal benefits	High	High	High	High	High	High	Low

Source: SIA Assessment

6. IMPLEMENTATION FRAMEWORK

DMF can be utilised to address the critical energy access gap in social infrastructure and for stimulating economic activity through DRE, for the betterment of the quality of life of mining-affected populations. Distributed solar installations provide the most robust technology solution to meet the power requirement of the focus segments. The modular nature of the technology implies that it can be deployed in various modes to suit the requirement at hand.

From the perspective of the focus segments, DMF can consider the following three modes of deployment:

1. Distributed solar on roof-top or ground mounted: For solarisation of nutrition, health and education sectors, rooftop and ground-mounted solar panels are ideally suited as they can cover the total or key energy requirements. DMF could look to install 2 kW systems at Anganwadi centres, health sub-centres and small schools to meet the lighting, fan, and water pumping requirements, and 5 kW systems on PHCs and large schools. Rooftop solutions of 2 kW to 10 kW can also be provided to micro-enterprises and local businesses to help reduce the diesel dependence.

2. Solar applications: In addition to rooftop and ground-mounted solar panels, there are a number of productive use applications of solar available to meet the specific requirements of the end-users. The most common solar application includes solar streetlights and solar water pumps with over 5 lakh and 3 lakh installations across India, respectively. DMF can prioritise solar water irrigation pumps of varying capacities for supporting the expansion of assured irrigation in the state, which is crucial for productivity enhancement as well as for building climate resilience. In view of the low mechanisation levels, the priority should be to provide farmers with USPC integrated solar pumps so that the surplus power generated can be utilised for other farm activities. The Jharkhand Solar Policy 2022 provides for promoting the deployment of standalone solar pump schemes, and for undertaking the demand aggregation model.

3. Solar mini-grids: DMF can also consider investing in a collective network-based solar solution to serve a cluster of demand loads located within a village, including in focus sectors and other common loads. Such systems of about 20 kW could be prioritised for compactly-located villages with no-grid connection or with very limited power supply.

DMFs in leading mining districts of India are adequately placed to provide upfront capital funding for the deployment of such solar-based solutions. However, the key concern to be addressed is to ensure sustainability of investments through structures that deliver effective O&M.

6.1 DRE IMPLEMENTATION MODELS

DMF has two broad models to consider for deployment of distributed solar solutions – capital expenditure (CAPEX) and the operational expenditure (OPEX). The CAPEX model is the most commonly employed in India. Under this, the consumer pays for the solar installations upfront through equity, loan, or subsidy support, fully owns the asset and takes on the responsibility/risks of operation, management, and maintenance of the system. This model provides a shorter payback period on investment, however, there are high operational and management risks.

In the OPEX or the Renewable Energy Service Company (RESCO) model, the upfront investments on the solar installations are made by the RESCO who also takes over the responsibility of operation, management, and maintenance of the system. In turn, the RESCO enters into an agreement with the consumer either for roof-leasing or for sale of generated power. In the rooftop leasing model, the RESCO pays a fixed rental fee to the roof owner and sells the generated power to the distribution company (discom) or any third party, while in the PPA model, the RESCO sells the generated power to the roof owner at a pre-determined tariff.

The advantage of the RESCO model is that there are no upfront costs for the consumer, and the O&M risks are borne entirely by the RESCO. Despite the advantages, there are many challenges due to which the RESCO model has failed to gain scale even in urban India, including their limited capacity to aggregate demand, payment-related risks associated with the PPAs and huge transaction costs for setting up small systems.[31] Due to these factors, RESCOs are typically limited to large-scale, and bankable commercial and industry customers.

For expanding the reach of both CAPEX and RESCO market, discoms are now playing a crucial facilitative role and is addressing some of the fundamental business challenges. Discoms are acting as agents of change by undertaking demand aggregation to create economies of scale, improving project bankability by ensuring contract enforcement and vetting vendors to ensure high quality of equipment and services. There are many utility-backed business models[32] emerging for CAPEX and RESCO installations in the rooftop segment:

- An anchored procurement model is emerging to support self-owned CAPEX installations wherein the discom facilitates consumers in procuring solar rooftop capacities by undertaking demand aggregation followed by competitive bidding. Under this, procurement is either facilitated through solar equipment, procurement and construction (EPC) companies (facilitated procurement model), or the discom directly acts as the developer (EPC contractor model).
- Discoms are also adopting an on-bill financing model to support CAPEX installations, wherein the discom along with anchored procurement also facilitates consumers in accessing finance as a bank loan through identified banking partners. Consumers pay back the loan as monthly instalments along with the electricity bill.
- Discoms can act directly as RESCO, thus owning and operating rooftop solar on consumer premises, for the sale of power back to the consumer through a mutually agreed PPA.
- Discoms are also engaging RESCOs through a tripartite agreement, wherein the discom buys power from the RESCO (who owns and operates the systems) and sells that power to the consumer. This reduces the payment risk for the RESCO.

The Jharkhand Solar Policy 2022 talks about exploring three specific models– anchored procurement, community solar, and solar partners (roof rent) models.

In rural segments across India, solar rooftop installations have largely come through CAPEX installation either at institutional buildings under government programmes or at private homes through government subsidies. Solar standalone systems have also been put up almost exclusively through a CAPEX route where government programmes or private philanthropic contributions have paid for the installations and transferred ownership to the end-users. Under this, the assets have either been fully subsidised for private use – such as solar home lighting systems and solar lanterns -- or community use such as solar *Jal Minar* for community water supply; or these have been partially subsidised for end users such as in case of solar water pumps for irrigation.

Solar applications and standalone systems carry a high sustainability risks in rural Jharkhand due to the lack of service market as well as low awareness among end-users. While EPC companies are obligated to provide five years of assured maintenance services, the obligation is not fulfilled due to the lack of local capacity of vendors and not enforced due to the lack of monitoring by implementing agencies. Even in scenarios where end-users are willing to pay for the repair, they are caught uninformed about who to approach for repairs, due to the lack of local ecosystem for after-sales services and solar technicians. Implementing agencies have tried to address this issue through remote monitoring in case of solar water pumps. While in the past the pumps were being monitored at a vendor-maintained disaggregated portals, under PM KUSUM, monitoring is being consolidated under a single national portal.

Meanwhile, innovations in the service delivery model in the rural segment have largely been limited to mini-grid deployments. Most of the government-funded mini-grids have been structured around community-based models, wherein a village energy committee or a beneficiary cooperative society acts as power producer, distributor and supplier of electricity.[33] The mini-grids are set up by the state renewable energy agency on an EPC mode, and handed over to the village committee/society for operations and management. The user fee for such systems typically accounts for operation and maintenance costs, including fuel costs (in the case of biomass projects), battery replacement cost and regular maintenance costs. The user fees are either collected directly by village committees through a project-specific bank account, or, in some cases, rural banks operating in the area act as intermediaries for bill collection.

Purely community-based models were typically seen to have short-lived success with systems often becoming dysfunctional due to the lack of proper maintenance and operations. Chhattisgarh Renewable Energy Development Agency (CREDA) has been successful in addressing this issue by adopting a multi-tier maintenance model wherein village committees are assigned only a limited role of oversight, while a plant operator is employed to take care of the regular operations. The overall O&M of the systems is the responsibility of a cluster technician, one appointed for every 10 to 15 villages, engaged through an O&M contractor.

In contrast to the government-funded mini-grids, the private sector deployment has largely been based on the demand-driven approach. Mini-grids of varying capacities have been installed in India with varying purposes, such as backed by an anchor commercial or industrial load or to service basic lighting and mobile charging requirements of households. The implementation models range from built, own, operate and maintain (BOOM), built, own, maintain (BOM) and built and maintain (BM), wherein user fee is charged either on weekly basis or on a prepaid 'pay-as-you-go' mode. In the case of private models, while the O&M is ensured by the private players, often billing and collection issues create sustainability challenge.

6.2 IMPLEMENTATION MODELS FOR DRE-DMF

DMF is ideally placed for aggregating demand in villages for solar interventions through a cluster-based approach wherein it can meet the requirements of social infrastructure as well as livelihood opportunities. Aggregation helps create a scale which drives down prices and attracts committed private players. It also builds an adequate scale for a solar ecosystem to be developed towards supporting a robust after-sales service market and for solar skill-building initiatives. Following demand aggregation, DMF can support the targeted segments through a mix of features adopted from existing and upcoming implementation models, with the core objective of ensuring investment sustainability. Key models to consider in this regard are:

CAPEX-based deployments backed by robust O&M

DMF has been spending primarily through the CAPEX route, providing funding for critical areas of investment in the district. In renewable energy, such investments have been made for the deployment of solar *Jal Minar* for community drinking water in a number of districts. While CAPEX is an established deployment model with many active EPC player participating, the key challenge with the model is that of ensuring robust O&M. Typically, with community deployments, the ownership of assets and the onus of repair is unclear leading to low efficiency of operations, while vendors' contractual obligation of five-year maintenance guarantee is not strictly enforced.

In undertaking future CAPEX investments in DRE, DMF needs to build a very strong maintenance and monitoring mechanism to ensure sustainability of such investments. This would entail the following measures:

- **Clear ownership of assets:** While the responsibility of performance monitoring and ensuring maintenance is well established in the case of individually-owned DRE assets, it should also be clearly spelled out for social and community assets. Establishing local ownership in this regard is important as direct beneficiaries have most at stake. This can also be ensured by incorporating a user-fee wherever feasible.
- **Online monitoring platform:** Online monitoring of the operational status and generation performance of the installed assets is crucial. Solar pump vendors have been installing pumps with machine-to-machine (M2M) sim cards to track performance for a real-time basis. Under the PM KUSUM scheme, an integrated platform is being developed by the MNRE to track the performance of all solar power pumps installed under the scheme across states. Rooftop vendors have also been providing such services to consumers to provide real-time information access. A M2M sim-based communication can be established across all solar installations made through DMF investments. The access to the online platform can be provided to direct beneficiaries and DMF representatives for robust monitoring.
- **Complaints registering and redressal mechanism:** Standard and simple operating procedures should be defined to register complaints with vendors. This could be through a dedicated phone number or through the online monitoring platform. The timeline of compliant response and redressal should be clearly defined in the tender document, and reports from deviation submitted with DMF. Other tender requirements, such as the need for setting up local service centres and keeping adequate spares etc. should be strictly implemented. The tender should build on a penalty and reward structure based on the complaint redressal efficiency of vendors to improve performance. The online monitoring platform can also be used to track complaint status. A rating system can be created for judging the efficiency of complaint redressal performance of the vendors. Setting up a Project Design and Monitoring Unit (PDMU) is crucial for solar engagement to monitor and assess vendor performance.

- **Provision for maintenance cost and battery replacement costs:** A payment plan should be devised upfront for meeting the maintenance and repair requirements of all DMF installations, past their five-year warranty periods. This should include a clear provision of battery replacement cost.
- **Training and skill building of local technicians:** Ensuring availability of local solar technicians is important to ensure good after-sale services beyond the five-year period of vendor-guaranteed maintenance. DMF should support skill building and livelihood programme focused on skilling and incubating local youth entrepreneurs to provide comprehensive solar installation and repair services. These individuals would act as on-ground workforce integrating technology into communities. Moreover, their presence at the time of installation would help build a trustworthy narrative with locals in the state.

Enabling RESCOs through payment security mechanism

DMF can develop and adopt a framework that attracts private players to act as RESCOs for solar installations in rural areas. While RESCO engagement would be at least 15-20 per cent more expensive compared to CAPEX deployment, it would help ensure sustainability of deployment. The entire risk and responsibility of solar asset O&M will be taken up by the RESCO. The installation quality risk and project management risks will be mitigated. However, RESCO players are currently not active in Jharkhand, and the model has largely not been tried in rural settings.

DMF can adopt an innovative model to develop RESCO players within rural Jharkhand, by giving local entrepreneurs adequate training on business requirements, along with a seed fund to launch business activities. Alternatively, DMF can also experiment with taking-up village electrification on a RESCO basis, where in established players are brought into the segment by proving payment security and viability gap funding to manage the off-taker arrangement risk.

Given the focus areas of social infrastructure and livelihood promotion, DMF can undertake CAPEX deployments for all solar-based solutions, including mini-grids, rooftop deployment and solar applications. However, RESCO-based model can also be tried for creating solar entrepreneurs that can further service private schools, hospitals and businesses. Each of these implementation models is individually discussed below:

Solar Village through CAPEX model with robust O&M measures

Pre-installation stage:

1. DMF enters into an MoU with the Department of Panchayati Raj and the Energy Department/JAREDA to utilise DMF funds for a solar village programme.
2. DMF launches a tender to identify a consultant agency for setting up a PDMU to support roll-out of the programme.
3. A detailed needs assessment study for the district is commissioned and initiated by the PDMU for identification of suitable villages.
4. Villages are identified for the solar village programme for setting up mini-grids of at least 20 kW capacity based on the pre-determined criteria of poor quality of power supply, compact location of demand centres, and the availability of adequate community land.
5. A combined tender for the entire district is launched in consultation with JAREDA, covering 100 villages for mini-grid deployment for supporting priority areas of health, nutrition, and education, as well as other community and commercial loads.
6. Standard government procurement mode of quality cum cost-based selection (QCBS) is deployed with reverse bidding to identify one or multiple vendors to install the mini-grids, in coordination with JAREDA.

Solar agri-irrigation pumping system, West singhbhum Dulu Ram, Surveyor

Installation stage:

7. DMF establishes village energy councils in each selected village for the management of the installed mini-grid systems. A bank account is opened in the name of each village energy council.
8. Gram panchayat provides a centrally-located community land area of at least 2,000 square feet for setting up the solar plant and supply infrastructure.
9. Vendor installs the equipment and provides after-sale services for a duration of five years, as well as training and handover commitment for one year. The vendor commits to setting up a district-level service centre with at least two skilled technicians.

Post installation stage:

10. Installed assets are handed over to the *Gram Panchayat*, and the village energy council is made responsible for overseeing the asset.
11. Operational performance of all mini-grids is accessed through a consolidated online monitoring platform, operated by the vendor for a five-year period. This platform is handed over to the DMF after five years.
12. DMF and JBVNL sign an MoU to make the system grid-connected and net-metered for the sale of surplus power back to the grid, in line with the existing state regulations.
13. To ensure effective delivery of after-sales services by the vendor during the first five years of contract commitment, payment to the vendor is split across project durations – 20 per cent during contract award, 50 per cent after installation, 10 per cent after one year of operation, and the remaining 20 per cent is paid as 5 per cent each year for the next four years. Vendor is also required to submit a 10 per cent bank guarantee at the time of contract award, which will be paid back after five years.
14. A subsidised user fee is charged from consumers for meeting O&M expenses. This can be a load-based charge or a consumption-based charged, at least equivalent to ₹2 per unit to ensure adequate collection of funds.
15. To ensure robust maintenance of installed assets beyond the five years, DMF helps establish an O&M fund by contributing up to 5 per cent of the capital cost upfront in the village energy council bank account. This fund is built over the years through the collected user fee. This supports payment of any equipment or battery replacement requirement, O&M requirement from fifth year onwards.
16. After five years, a tender for AMC is launched for system O&M. The payment for AMC comes from the O&M Fund.

Table 6.1: Key features of solar village model proposed through the CAPEX model

Technical features	Ownership structure	Gram panchayat
	Operation & management	• Village energy council for oversight • Salaried trained mini-grid operator for day-to-day operations • Online/remote performance monitoring
	After sales services	• Vendor provides services for the first five years, ensured through performance monitoring and staggered payments • AMC to be awarded after five years through the O&M fund
Financial features	Capital expenditure	• Provided by DMF
	O&M expenses	• Fund established through upfront contributions from DMF (5 per cent of capex) and user fees payment by beneficiary departments/ individuals aligned to their connected load (equivalent to at least ₹2 per unit)
	User fees	• Since capex is subsidised, beneficiaries are required to pay a user fee covering for O&M cost.

SOLAR VILLAGES THROUGH RESCO

DMFs can consider mobilising RESCOs to solarise villages due to the benefit of assured O&M services. In such a model, a mini-grid infrastructure of 20 kW solar capacity is set up by the RESCO on the community land provided by the *Gram Panchayat* through a no-cost lease. RESCO sets up the generation and distribution infrastructure, maintains the assets for the project duration and supplies power to concerned beneficiary departments and individuals in exchange of a user fee. RESCO generates consolidated bills for the respective departments based on the ongoing grid tariff.

In such a model, the difference between grid tariff and RESCO's cost of supply would be coved by a viability gap fund (VGF) set up by the DMF. The DMF would also need to set aside a risk fund to cover the risk of non-payment by the consumer departments. To reduce the subsidy burden, RESCO can be encouraged and allowed to add additional load, with clear prioritisation of social sectors. In case of significant surplus availability, the RESCO could also look to make the system grid-connected and net-metered for the sale of power to the discom under a PPA.

The advantage of such a RESCO model is that the sustainability of the installed assets can be assured, however, the overall cost of such a set up would be 15 to 20 per cent higher than the CAPEX installations. Further, instead of a 100 per cent upfront capital subsidy, the costs for DMF would be reduced to an amount equivalent to the VGF for the project duration.

Also, structures would need to be built through which DMF can provide adequate risk coverage to the RESCO throughout the life of the project.

Solarisation of social infrastructure through CAPEX model with robust O&M measures

Pre-installation phase:

1. DMF enters into an MoU with the relevant state departments, energy department/JAREDA to utilise the DMF funds for launching an energy access programme for social infrastructure.
2. DMF launches a tender to identify a consultant agency for setting up a PDMU.
3. Detailed energy needs assessment is done by the PDMU covering all government-owned:
   a. Education centres
   b. Health centres
   c. Anganwadi centres
4. A programmatic tender for the entire district is launched through 100 per cent CAPEX from DMF in coordination with JAREDA, covering all the government-owned health, nutrition and education centres for distributed solar deployment as:
   a. Solar for schools
   b. Solar for health centres
   c. Solar for Anganwadi centres
5. Standard government procurement mode of QCBS is deployed with reverse bidding to identify one or multiple vendors to install the rooftop/standalone deployments, in coordination with JAREDA.

Installation phase:

6. The concerned departments open a dedicated bank account to set aside funds for O&M of these assets.
7. Respective beneficiary departments provide access to adequate rooftop/ground space to install the solar equipment.
8. Vendor installs the equipment and provides after-sale services for a duration of five years, as well as training and handover commitment for one year. Vendor commits to setting up a district-level service centre with at least two skilled technicians for each programme.

Post-installation phase:

9. Installed assets are handed over to the respective beneficiary department, whose local representative is made responsible for overseeing the asset.
10. Operational performance of all solar assets can be accessed through a consolidated online monitoring platform, to be developed by the vendor and accessed by DMF and the concerned departments. The platform is operated by the vendor for a five-year period and is handed over to the DMF after five years.
11. Beneficiary departments/individuals and JBVNL sign MoU to make the system grid-connected and net-metered for sale of surplus power back to the grid, in line with the net metering guidelines.
12. To ensure effective delivery of after-sales services by the vendor during the first five years of contract commitment, payment to the vendor is split across project durations – 20 per cent during contract award, 50 per cent after installation, 10 per cent after one year of operation, and the remaining 20 per cent is paid as 5 per cent each year for the next four years. Vendor will also be required to submit a 10 per cent bank guarantee at the time of contract award, which will be paid back after five years.
13. For meeting the O&M expenses beyond the five years, DMF provides an upfront seed capital of up to 40 per cent of the O&M cost requirement during the first five years of project operations. The concerned departments contribute the remaining 60 per cent amount as user fees. This O&M fund is to be utilised by the concerned department to award AMCs for the solar assets from the sixth year onwards.

Table 6.2: Key features of solarization of social infrastructure through CAPEX model

Technical features	Ownership structure	• Beneficiary departments
	Operation & management	• Beneficiary departments' local representatives for oversight • Online/remote performance monitoring
	After-sales services	• Vendor provides services for first five years, ensured through performance monitoring and staggered payments • AMC to be awarded after five years through the O&M fund
Financial features	Capital expenditure	• 100 per cent by DMF
	O&M expenses	• O&M fund established through contributions from DMF and beneficiary departments in 40-60 ratio for the first five years
	User fees	• Since capex is subsidised, beneficiary departments are only required to pay for the maintenance cost as 60% contribution towards O&M fund

Off-grid solar irrigation pumps through CAPEX model

Pre-installation phase:

1. DMF enters into an MoU with the agriculture department and energy department/JAREDA to utilise DMF funds for energy access support for irrigation.
2. DMF launches a tender to identify a consultant agency for setting up a PDMU.
3. DMF commissions PDMU to undertake a needs assessment study, and undertakes beneficiary identification in coordination with the agriculture department.
4. DMF designs the solar pumps programmes to provide up to 90 per cent CAPEX for each installation, while 10 per cent is required to be provided by the farmers. DMF signs an MoU with an active Grameen Bank to support farmers in accessing loans for their 10 per cent contribution. The subsidy scale is aligned with the ongoing PM KUSUM scheme to ensure off-takers.
5. A combined tender for the entire district is launched in consultation with JAREDA covering all assessed villages in the district for supporting 1,000 solar-based irrigation applications, for various categories of sub-1 HP to 7.5 HP solar water pumps equipped with the USPC.
6. Standard government mode of QCBS is deployed with reverse bidding to identify one or multiple vendors to install the solar pumps.

Application and installation phase:

7. Vendors are required to mobilise farmers from the list of beneficiaries identified by the PDMU for installation and pump setting. Solar pumps are allocated to the farmers on a first-come-first-serve basis.
8. Vendors install the equipment and provide after-sale services for a duration of five years, as well as training and handover commitment to farmers for one year. The vendor commits to setting up a district-level service centre with at least two skilled technicians, and adequate spares.

Post-installation phase:

9. Each installed asset is handed over to the respective farmers.
10. The operational performance of all the solar pumps can be accessed through a consolidated online monitoring platform, operated by the vendor for a five-year period. This platform is handed over to the DMF after five years.

14. To ensure effective delivery of after-sales services by the vendor during the first five years of contract commitment, payment to the vendor is split across project durations – 20 per cent during contract award, 50 per cent after installation, 10 per cent after one year of operation, and the remaining 20 per cent is paid as 5 per cent each year for the next four years. Vendor will also be required to submit a 10 per cent bank guarantee at the time of contract award, which will be paid back after five years.
15. PDMU continues to support farmers with accessing vendor services, following up on complains on non-performance or delays in repair services etc.
16. After five years of pump operations, farmers are themselves responsible for ensuring the maintenance of the pumps through private solar repair centres.

Table 6.3: Key features of off-grid solar irrigation pumps through the CAPEX model

Technical features	Ownership structure	• Beneficiary farmer
	Operation & management	• Beneficiary farmer • Online/remote performance monitoring
	After-sales services	• Vendor provides services for first five years, ensured through performance monitoring and staggered payments • Farmers responsible for repair and maintenance
Financial features	Capital expenditure	• 90% provided by DMF, 10% by farmer
	O&M expenses	• Included in the tender cost during first five year, made privately by farmer later
	User fees	• None

Solar entrepreneurs for comprehensive ecosystem development

DMF launches Solar Entrepreneurship Programme to create solar entrepreneurs in rural Jharkhand by developing entrepreneurial and solar-oriented skills among the unemployed rural youths willing to create solar-based micro-enterprises. The programme targets to develop two specific sets of solar businesses:

A. Solar energy service entrepreneurs (SESEs): The first component of the programme aims to train and incubate 50 solar entrepreneurs who can provide comprehensive solar installation, operation, and maintenance services in rural Jharkhand. These SESEs are capacitated to provide RESCO services to MSMEs, private schools, private hospitals, and other load centres for at least 50 kW capacity. Under this, the SESEs will install solar panels and batteries at the premises of these establishments without any upfront payment, and instead, charge a flat monthly user fee in line with the connected load. The SESEs are encouraged to expand the business to provide CAPEX installations and O&M services to meet the market demand.

B. Solar energy repair entrepreneurs (SEREs): The second component of the programme aims to train and incubate 100 solar repair technicians for delivering comprehensive after- sales services in rural Jharkhand. These entrepreneurs are capacitated with technical training and seed funding support for business initiation.

Programme components:

The programme supports solar entrepreneurship development through comprehensive training and skill building as well as seed funding to roll out the business.

- **Entrepreneurship training:** The solar entrepreneurs are trained in traditional and emerging skills of business incorporation, management, expansion, and sustenance. These include training for business registration, business planning, finance mobilisation, client lead generation, credit appraisal and acquisition, contract management, human resources acquisition, accounting, procurement, revenue and pricing analysis, and the use of information technology tools for business operations and tracking business performance.

- **Technical training:** Solar entrepreneurs are provided comprehensive technical training. This includes building understanding of the basic principles of DRE technologies and applications, including that of solar panels, solar water pumps, solar water heaters, solar home lighting system, solar water pumps etc. Technical training for assembling, site evaluation, installation, and maintenance of systems on rooftops or other structures is provided. In addition, basic training of setting up batteries, pumps, fans, controls, and support structures is also provided, followed by procedure for final testing the installed system. Training for repair is especially focused on regular service and maintenance of existing systems, and on troubleshooting equipment deficiencies or malfunctions. The entrepreneurs are provided resource and reference material, including manuals, videos etc. in local language. The six-month course is driven by practical lessons, comprising over 60 per cent of the course delivery.
- **Credit availability:** The seed funding is made available as a mix of equity and loan, as follows:
  - In case of SESEs, DMF supports each entrepreneur with 60 per cent of the required funds as equity grant for setting up 50 kW capacity, while the remaining 40 per cent is facilitated as loan through a local Grameen Bank, if required by the entrepreneur.
  - In case of SEREs, seed fund is provided for procurement equipment required for delivering the repair and maintenance services.

Programme rollout steps:

1. DMF signs an MoU with a relevant organisation – such as Entrepreneurship Development Institute of India or National Institute for Entrepreneurship and Small Business Development or the National Alliance of Young Entrepreneurs – specialising for entrepreneurship building to support in the development of the entrepreneurship training programme.
2. DMF signs an MoU with organisations such as the National Institute of Solar Energy or Skill Council for Green Jobs to provide training in solar installations, maintenance, and repair activities to support in the development of the technical training programme.
3. DMF signs an MoU with local Grameen Bank for the disbursement of loans to SESEs, which is up to 40 per cent of the required investment for 50 kW capacity for each SESE.
4. DMF launches a tender to engage a technical consultant to roll out the programme and undertake all the implementation activities on the behalf of DMF.
5. The selected technical consultant undertakes the following set of comprehensive activities for project rollout:
   - Mobilisation and selection of potential entrepreneurs based on objective selection criteria through engagement with community-based institutions.
   - Facilitation of comprehensive business and technical training through identified specialised organisations.
   - Facilitation of procurement process by linking solar entrepreneurs with key equipment suppliers.
   - Facilitation of market development by linking solar entrepreneurs with key MSME groups, and other major load centres.
   - Support entrepreneurs in business registration and accessing bank finance, doing client due diligence, undertaking user fees assessment etc.
6. DMF to provide seed capital to SESEs for starting the business for setting up 50 kW of solar RESCO business, through 60 per cent of the capex requirement provided as equity grant by DMF and the remaining 40 per cent as bank loan. For SEREs, the entire seed funding is provided as grant from DMF.
7. Technical consultant handholds rural entrepreneurs for the initial six months of business operations, with monthly meetings to support with business operations query.

istockphoto.com

7. DMF INITIATIVE: CLEAN ENERGY FOR SOCIAL INFRASTRUCTURE AND LIVELIHOOD

District Mineral Foundation (DMF) can rollout Clean Energy for Social Infrastructure and Livelihood (CESIL) initiative as a bundled solarisation programme in the mining affected rural areas for comprehensively addressing the energy requirements of health, nutrition and education sectors, as well as supporting livelihood enhancement through farm and non-farm sectors. Energy is a fundamental and crucial requirement for improving the quality of services being delivered by social infrastructure and for improving the productivity of livelihood activities. Given the functional electrification and power supply deficit in rural Jharkhand, prioritising investments on solutions that can ensure quality power supply is necessary for elevating quality of life and reducing the multi-dimensional poverty. There are merits to adopting a bundling approach as it brings in the benefits of economies of scale and enables creation of a local ecosystem for solar technology that can ensure sustainability of investments. Meanwhile, the budget remains well within the affordability range of DMF.

7.1 TARGETS

A district-level CESIL initiative can prioritise investments across five broad components of work, including: (1) education, (2) health and nutrition, (3) livelihood support, (4) solar village and (5) solar enterprises.

- **Target 1:** CESIL targets development of 100 solar villages, wherein the social and economic power requirements of a village can be supported by centralised solar plant of up to 20 kW capacity. This would lead to a solar capacity addition of 2 MW in each district.
- **Target 2:** CESIL undertakes segment specific solarisation programme – (a) solarisation of health, (b) solarisation of nutrition, and (c) solarisation of education. These programmes would respectively aim to cover all the government health centres, Anganwadi centres, and schools within the district with 2 kW to 5 kW systems with 2-6 hours of power backup.
- **Target 3:** CESIL supports 1,000 farmers with deployment of solar water pumps of varying capacities in each focus district. This can be expanded to include more beneficiaries in later phases of the initiative.
- **Target 4:** CESIL supports a comprehensive programme for training and incubating 100 solar energy service entrepreneurs, and 50 solar energy repair entrepreneurs.

Such a comprehensive CESIL initiative would lead to an aggregate installation of 14.44 MW of solar capacity in Chatra, 17.68 MW in Dhanbad, 16.79 MW in Hazaribagh, 12.44 MW in Ramgarh and 17.86 MW in West Singhbum.

Table 7.1: District-wise target capacities under the proposed CESIL initiate of DMF

District	Category	Total to cover	Covered in the scheme	Solar capacity potential (kW)
Chatra	Anganwadi centre	1,124	1,124	2,248
	Health sub-centre	93	93	186
	PHC	9	9	45
	School*	1,488	1,488	4,464
	Solar village	1,377	100	2,000
	Solar pump	Depending on demand	1,000	3,000
	Solar energy service entrepreneurs	Depending on demand	50	2,500
	Solar energy repair entrepreneurs	Depending on demand	100	0
	Total			**14,443**

District	Category	Total to cover	Covered in the scheme	Solar capacity potential (kW)
Dhanbad	Anganwadi centre	1,911	1,911	3,822
	Health sub-centre	140	140	280
	PHC	33	33	165
	School*	1,971	1,971	5,913
	Solar village	1,333	100	2,000
	Solar pump	Depending on demand	1,000	3,000
	Solar energy service entrepreneurs	Depending on demand	50	2,500
	Solar energy repair entrepreneurs	Depending on demand	100	0
	Total			**17,680**
Hazaribagh	Anganwadi centre	1,770	1,770	3,540
	Health sub-centre	129	129	258
	PHC	13	13	65
	School*	1,809	1,809	5,427
	Solar village	1,324	100	2,000
	Solar pump	Depending on demand	1,000	3,000
	Solar energy service entrepreneurs	Depending on demand	50	2,500
	Solar energy repair entrepreneurs	Depending on demand	100	0
	Total			**16,790**
Ramgarh	Anganwadi centre	1,042	1,042	2,084
	Health sub-centre	243	243	486
	PHC	25	25	125
	School*	748	748	2,244
	Solar village	351	100	2,000
	Solar pump	Depending on demand	1,000	3,000
	Solar energy service entrepreneurs	Depending on demand	50	2,500
	Solar energy repair entrepreneurs	Depending on demand	100	0
	Total			**12,439**
West Singhbhum	Anganwadi centre	2,330	2,330	4,660
	Health sub-centre	155	155	310
	PHC	7	7	35
	School*	1,784	1,784	5,352
	Solar village	1,642	100	2,000
	Solar pump	Depending on demand	1,000	3,000
	Solar energy service entrepreneurs	Depending on demand	50	2,500
	Solar energy repair entrepreneurs	Depending on demand	100	0
	Total			**17,857**

Note: For solar capacity estimates, the average deployment is taken to be 2 kW for Anganwadi and health-sub centres, 5 kW for PHCs, 3 kW for school and micro-enterprise, 3 kW for solar pumps, and 20 kW for solar village. *Number of schools are estimated to reflect the schools owned and operated by the department of education
Source: SIA Assessment

7.2 BUDGET

The estimated budget for the CESIL initiative for setting up solar capacities across the focus districts would range from ₹94 crore in the case of Ramgarh, which has a relatively smaller rural area to ₹132 crore in the case of West Singhbhum and Dhanbad. This accounts for 100 per cent subsidy provided for Anganwadi centres, health sub-centres, PHCs, schools, and solar villages; while solar pumps are provided at 90 per cent subsidy.

Under the proposed structure, 25-30 per cent of the investments accrue to schools, about 15 per cent towards the development of solar villages, and 10 to 15 per cent towards solar pumps.

Meanwhile, additional funds (₹5-10 crore) would be required at the planning stage and for supporting to create an ecosystem for monitoring and maintenance of installed equipment.

Table 7.2: District-wise investment requirement for setting up solar and battery capacities proposed by CESIL initiate of DMF

Category	Chatra	Dhanbad	Hazaribagh	Ramgarh	West Singhbhum
All Anganwadi centres	14.05	23.89	22.13	13.03	29.13
All Health sub-centres	1.30	1.96	1.81	3.40	2.17
All PHCs	0.39	1.42	0.56	1.08	0.30
All Schools	34.97	46.32	42.51	17.58	41.92
100 solar villages	22.96	22.96	22.96	22.96	22.96
1,000 Solar pumps	18.90	18.90	18.90	18.90	18.90
50 Solar energy service entrepreneurs	15.25	15.25	15.25	15.25	15.25
100 Solar energy repair entrepreneurs	1.50	1.50	1.50	1.50	1.50
Total	109.32	132.20	125.61	93.69	132.13

Note: The estimates exclude the funding required for project planning, technical assistance, and online platform development; funding requirement of solar villages reflects the capex cost, and 90 per cent subsidy requirement for solar pumps.
Source: SIA estimates

7.3 STEPS

The CESIL programme of DMF would comprise three broad stages to ensure effective and sustainable integration of DRE in focus sectors by engaging in proper planning for the implementation, followed by calls for procurement and implementation and ending with proper monitoring and maintenance of installations. The detailed steps for delivering the project are as follows:

1. The inception stage of the project entails DMF signing an MoU with all the concerned government departments to utilise DMF funds for energy access support, aligned with the objectives of the Jharkhand Solar policy 2022 and the Jharkhand DMF Rules 2016. The agencies and departments to collaborate include:
    a. The state Department of Energy and JAREDA for renewable energy deployment
    b. Department of Health, Medical Education and Family Welfare for solarisation of health centres
    c. Department of Women, Child Development and Social Security for solarisation of Anganwadi centres
    d. Department of School Education & Literacy Development for solarisation of schools
    e. Department of Agriculture, Animal Husbandry & Co-operative, and Department of Scheduled Tribe, Scheduled Caste, Minority and Backward Class Welfare for solarisation of the primary sector

f. Department of Panchayati Raj for the implementation of solar villages and providing overall coordination support to the initiative
g. Department of Labour, Employment, Training and Skill Development for skill building efforts required to support ecosystem development

2. PDMU, led by a technical consultant/expert agency, is engaged to help plan, execute, and implement this initiative. The agency would be made responsible for the detailed assessment, design of the programme, tendering and selection of vendors, providing comprehensive knowledge and management support to the DMF to ensure efficiency of engagement and investment and monitoring the entire program for five years.
3. For the solar village programme, village energy council is set up in every solar village, comprising 4-5 members elected by the *Gram Sabha* for a broader institutional support. A bank account would be opened in the name of the village energy council to fund the O&M of the mini grid.
4. For solarisation of education, health centres and Anganwadis, the respective departments will take the ownership of the solar assets. A bank account will be opened, with contribution from DMF and the respective departments, to fund the O&M of the DRE infrastructure.
5. Following a bottoms-up approach, DMF initiates detailed studies with the support of PDMU to finalise the initiative design, including the scope and scale of intervention. This includes the following measures:
   a. Village-level mapping of consumption points across health, education, nutrition, irrigation, microenterprise etc.
   b. Identification of the sizing requirement across segments.
   c. Identification of targets for various deployment modes – mini-grid application vs standalone systems vs applications.
   d. Identification of targets for various implementation models – CAPEX vs OPEX.
6. CESIL initiative design is finalised to reflect the requirements of the ground, along with a detailed project report. Depending on the coordination with counter party departments and the findings of the ground report, DMF can choose to implement the project across one or several of the focus sectors – health, nutrition, health, and livelihood.
7. The initiative is included in the annual plan drafted by the Management Committee and presented for approval from the Governing Council.
8. Following the approvals, procurement process is initiated aligned with the e-procurement guidelines of the government. The PDMU is given the responsibility of ensuring alignment with MNRE and JAREDA technical specifications and requirements, as well as of mobilising participation in the tender from serious players. The tender specifications are designed to ensure good quality of installation and after-sales services.
9. Implementation of the projects is strictly covered by tender specification to ensure high quality of installation. The technical consultant is made responsible to inspect and prepare a detailed report of all the installations put up under the CESIL initiative.
10. A consolidated platform is created within the DMF website to collect operational data from all the installed solar DRE systems. The PDMU reviews the monitoring report of the operations of these applications on a monthly basis.
11. DMF coordinates with the relevant agencies such as National Institute of Solar Energy or Skill Council for Green Jobs for local skill development through the inclusion of solar-related courses in the local Industrial Training Institutes and other skill building centres.
12. DMF incubates solar entrepreneurs to set up service centre infrastructure and provide RESCO services at the district level.

Figure 7.1: Implementation activities under CESIL initiative

01 INCEPTION & PLANNING
- MoU with government department
- Engaging PDMU
- Setting up village council with bank accounts
- Assessment study, analysis, and initiative design
- DPR & feasibility report preparation

02 APPROVAL & TENDERING
- Inclusion in annual plan by MC
- Approval by GC
- Drafting tenders aligned with MNRE & JAREDA specifications
- Call for procurement & evaluation
- Tender award and contract signed

03 FUND SANCTION
- Funds are set aside in line with the programme design requirement

04 IMPLEMENTATION OF ASSETS & MONITORING PLATFORM
- Study of demand centers, and mobilization of end-users as required
- Installation of equipment
- Commissioning and project completion report by both vendor and technical consultant
- Developing integrated monitoring platform on existing DMF website

05 OPERATIONS, MAINTENANCE & MONITORING
- Five-year O&M by vendor
- Funds for AMCs allocated for sixth year onwards
- Regular physical and online monitoring by village council/user agency and monthly monitoring by DMF
- AMC awarded from sixth year onwards

06 DEVELOPMENT OF SOLAR ENTREPRENEURS
- Coordinating with appropriate institutions for entrepreneurship training
- Coordinating with NISE / SCGJ for technical training on solar installation, O&M
- Engage vendors for project rollout
- Selection of entrepreneurs, capacity building and seed fund support
- Handholding support for one year for business roll-out

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